Shellfish Stocks and Fisheries Review 2016-2017






BIM
Bord Iascaigh Mhara
Irish Sea Fisheries Board

Marine Institute
Foras na Mara

Shellfish Stocks and Fisheries

Review 2016-2017

An assessment of selected stocks

The Marine Institute and Bord Iascaigh Mhara

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Irish Sea Fisheries Board

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Photographs on cover by J. White (Lobster), M. O'Cuaig (Oyster), B. Whelan (Razor clams), M. O'Cuaig (Cockle), M. O'Cuaig (Razor clam), M. O'Cuaig (Scallop and Zostera)

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1 Introduction

This review presents information on the status of selected shellfish stocks in Ireland. In addition, data on the fleet and landings for shellfish species (excluding *Nephrops* and mussels) are presented. The intention of this annual review is to present stock assessment and scientific advice for shellfisheries which may be subject to new management proposals or where scientific advice is required in relation to assessing the environmental impact of shellfisheries especially in areas designated under European Directives. The review reflects the recent work of the Marine Institute (MI) in the biological assessment of shellfish fisheries.

The information and advice presented here for shellfish is complementary to that presented in the MI Stock Book on demersal and pelagic fisheries. Separate treatment of shellfish is warranted as their biology and distribution, the assessment methods that can be applied to them and the system under which they are managed, all differ substantially to demersal and pelagic stocks. In particular a number of shellfish fisheries are now under Natura 2000 site management regimes.

Shellfish stocks are not generally assessed by The International Council for the Exploration of the Sea (ICES) and although they come under the competency of the Common Fisheries Policy they are generally not regulated by TAC and in the main, and other than crab and scallop, are distributed inside the national 12 nm fisheries limit. Management of these fisheries, by the Department of Agriculture, Food and Marine (DAFM), is based mainly on minimum landing sizes but increasingly also by the use of input or output controls.

A co-operative management framework introduced by the Governing Department and BIM in 2005 (Anon 2005) and under which a number of management plans were developed was, in 2014, replaced by the National and Regional Inshore Fisheries Forums (RIFFs). These bodies are consultative forums the members of which are representative of the inshore fisheries sector and other stakeholder groups. The National forum (NIFF) provides a structure with which each of the regional forums can interact with each other and with the Marine Agencies, DAFM and the Minister.

Management of oyster fisheries is the responsibility of The Department of Communications, Energy and Natural Resources (DCENR) implemented through Inland Fisheries Ireland (IFI). In many cases, however, management responsibility for oysters is devolved through Fishery Orders or 10 year Aquaculture licences to local co-operatives.

The main customers for this review are DAFM the RIFFs, NIFF, DCENR and IFI.

2 Shellfish Fleet

2.1 Fleet capacity

The total registered capacity of the Irish fishing fleet, as of December 2017, was 63,250 gross tonnes (GTs) and 1,992 vessels. The polyvalent general segment was the largest and included 31,463 GTs and 1,360 vessels. The polyvalent potting segment had 361 registered vessels and 761 GTs while the bivalve (specific) segment had 2,150 GTs and 140 vessels.

2.2 Fleet structure

The Irish fleet is currently divided into 5 segments. Of these five segments (Aquaculture, Specific, Polyvalent, Beam Trawl and RSW Pelagic) two are broken into sub-segments, namely the Polyvalent and Specific Segments. Aquaculture vessels do not have fishing entitlements. Beam trawl vessels fish mixed demersal fish using beam trawls and RSW Pelagic are large pelagic vessels with refrigerated seawater tanks and target pelagic species. The **Polyvalent Segment** is divided into the following four Sub-segments;

(1) Polyvalent [Potting] Sub-segment; vessels of <12 m length overall (LOA) fishing exclusively by means of pots. Such vessels are also <20 GT. Target species are crustaceans and whelk.
(2) Polyvalent [Scallop] Sub-segment; vessels ≥10 m LOA with the required scallop (*Pecten maximus*) fishing history. These vessels also retain fishing entitlements for other species excluding those listed in Determination No. 21/2013.
(3) Polyvalent [<18 m LOA] Sub-segment;
Vessels with fishing entitlements for a broad range of species other than those fisheries which are authorised or subject to secondary licencing as listed in Determination No. 21/2013 (http://agriculture.gov.ie/fisheries/).
(4) Polyvalent [≥18 m LOA] Sub-segment;
Vessels with fishing entitlements for a broad range of species other than those fisheries which are authorised or subject to secondary licencing as listed in Determination No. 21/2013.

The **Specific Segment**, which entitles vessels to fish for bivalves only, is divided into the following two Sub-segments;
(1) Specific [Scallop] Sub-segment for vessels ≥10 m LOA with the required scallop (*Pecten maximus*) fishing history;
(2) Specific [General] Sub-segment for all other Specific vessels irrespective of LOA.

In December 2017 almost 73% of vessels in the fleet were under 10 m in length. These are typically open or half-decked traditional fishing vessels that fish seasonally in coastal waters. Ninety five percent of polyvalent potting vessels were less than 10 m in length and all were under 12 m. Approximately half of the specific fleet of 140 vessels were under 10 m.

2.3 Fleet capacity transfer rule

The following rules apply to the transfer of capacity within segments;

(1) Polyvalent capacity is privately transferable within its segment. Where an applicant for a polyvalent fishing licence has evidence of holding such capacity (a capacity assignment note) and has an approved fishing vessel then a fishing licence will be issued to such an applicant. This applies to over 18 m and under 18 m sub-segments.
(2) Excluding the fisheries licenced by secondary permit the polyvalent capacity is not coupled to any given quota or entitlement. The capacity assignment note simply enables the vessel owner to complete the registration of a vessel.
(3) In the case of fisheries fished with a permit or secondary licence the authorisation to fish such stocks is effectively coupled with the capacity if the capacity is transferred i.e. this transfer is essentially a transfer of track record in the particular fishery. Such entitlement is, however, also governed by TAC & Quota and any other policies or harvest control rules that might apply to those stocks.
(4) Polyvalent potting capacity is not transferable within its segment other than to first degree relatives of the person to which the capacity was originally assigned.
(5) Polyvalent general capacity that is not attached to a registered vessel for a period of more than 2 years expires.
(6) When polyvalent potting capacity is no longer attached to a registered vessel then the capacity reverts to the licencing authority. This capacity is not re-issued other than to first degree relatives.

2.4 Vessels targeting Shellfish

The shellfish fleet is here defined as vessels under 13 m in length as the vast majority of such vessels depend largely on shellfish. This cut off, however, is not reflective of any licencing or policy condition and many of these vessels also fish for other species. In addition a number of vessels over 18 m target crab mainly in offshore waters (vivier vessels) and 13 vessels over 12 m in length were authorised to fish for scallops in 2017.

The number of vessels in the Shellfish fleet increased significantly in 2006-2007 as a result of the 'Potting Licence Scheme' which regularised many vessels that were operating outside of the registered fleet prior to 2006. The number of vessels in the polyvalent potting segment is declining year on year due to de-registration or transfer from this restricted segment, which limits fishing entitlement. The number of vessels in the polyvalent general segment increased year on year between 2006 and 2012 by an average of 53 vessels per year. This trend was reversed in the period 2012-2017 during which time the number of vessels declined by 98 (**Table 1**, **Table 2**, **Figure 1**).

The average length and capacity of vessels in the polyvalent and specific segments declined between 2006 and 2012. A further decline in the size of specific (bivalve) vessels occurred in 2015. Polyvalent vessels under 13 m in length were on average 0.7GT smaller in 2014 compared to 2007.

Polyvalent potting vessels have higher engine capacities in proportion to their gross tonnage than polyvalent general vessels. Aquaculture and specific vessels have lower engine capacities compared to polyvalent or potting vessels.

Table 1. Length and capacity profile of the Irish Shellfish fleet 2006-2017 (<13 m polyvalent, all polyvalent potting, all vessels in specific segment, all aquaculture vessels). Vessels over 18 m fishing for crab and scallop are not included.

Year	Aquaculture	Polyvalent General	Polyvalent Potting	Specific	Total
Number of vessels					
2006	3	953	80	97	1133
2007	13	999	490	93	1595
2008	46	1081	482	115	1724
2009	60	1146	474	124	1804
2010	68	1198	467	120	1853
2011	78	1239	461	118	1896
2012	85	1269	460	122	1936
2013	86	1233	454	117	1890
2014	89	1218	448	112	1867
2015	89	1226	426	123	1864
2016	87	1218	404	126	1835
2017	83	1171	363	125	1742
Average length					
2006	7.96	7.95	7.32	9.40	8.03
2007	8.20	7.84	6.76	9.38	7.60
2008	7.41	7.73	6.71	9.32	7.55
2009	7.15	7.65	6.71	9.33	7.50
2010	7.11	7.57	6.67	9.36	7.44
2011	7.23	7.54	6.64	9.39	7.42
2012	7.24	7.51	6.62	9.36	7.41
2013	7.14	7.50	6.62	9.41	7.39
2014	7.15	7.53	6.62	9.52	7.41
2015	7.10	7.53	6.62	9.56	7.44
2016	7.15	7.52	6.59	9.66	7.44
2017	7.09	7.56	6.59	9.70	7.49
Average GT per vessel					
2006	3.26	4.68	2.96	7.24	4.78
2007	3.75	4.43	2.29	7.06	3.92
2008	3.29	4.20	2.22	6.88	3.80
2009	2.87	4.08	2.22	6.70	3.73
2010	2.72	3.96	2.16	6.73	3.64
2011	2.85	3.91	2.12	6.80	3.61
2012	2.84	3.85	2.10	6.90	3.58
2013	2.71	3.87	2.11	7.09	3.59
2014	2.72	3.92	2.11	7.14	3.62
2015	2.72	3.95	2.10	7.30	3.69
2016	2.87	3.93	2.09	7.50	3.72
2017	2.77	3.97	2.10	7.73	3.79
Average Kws per vessel					
2006	45.45	35.49	44.50	65.64	38.72
2007	53.76	34.43	30.29	62.58	34.96
2008	37.68	32.66	29.79	60.44	33.84
2009	33.86	31.45	29.26	57.57	32.75
2010	31.55	30.43	28.93	59.38	31.97
2011	32.89	30.09	28.28	60.32	31.65
2012	33.65	29.60	28.03	61.55	31.42
2013	32.48	29.61	28.06	64.31	31.52
2014	32.11	30.20	28.23	65.84	31.96
2015	32.17	30.38	27.85	67.15	32.31
2016	30.32	30.19	27.35	68.86	32.22
2017	30.72	30.61	28.22	68.76	32.85

Table 2. Annual change and percentage change in the numbers of vessels per fleet segment in the under 13 m Shellfish fleet 2006-2017.

Year	Aquaculture	Polyvalent General	Polyvalent Potting	Specific	Total
Change in number of vessels					
2006-2007	10	46	410	-4	462
2007-2008	33	82	-8	22	129
2008-2009	14	65	-8	9	80
2009-2010	8	52	-7	-4	49
2010-2011	10	41	-6	-2	43
2011-2012	7	30	-1	4	40
2012-2013	1	-36	-6	-5	-46
2013-2014	3	-15	-6	-5	-23
2014-2015	0	8	-22	11	-3
2015-2016	-2	-8	-22	3	-29
2016-2017	-4	-47	-41	-1	-93
% Change in number of vessels					
2006-2007	333.33	4.83	512.50	-4.12	40.78
2007-2008	253.85	8.21	-1.63	23.66	8.09
2008-2009	30.43	6.01	-1.66	7.83	4.64
2009-2010	13.33	4.54	-1.48	-3.23	2.72
2010-2011	14.71	3.42	-1.28	-1.67	2.32
2011-2012	8.97	2.42	-0.22	3.39	2.11
2012-2013	1.18	-2.84	-1.30	-4.10	-2.38
2013-2014	3.49	-1.22	-1.32	-4.27	-1.22
2014-2015	0.00	0.66	-4.91	9.82	-0.16
2015-2016	-2.25	-0.65	-5.16	2.44	-1.56
2016-2017	-4.60	-3.86	-10.15	-0.79	-5.07

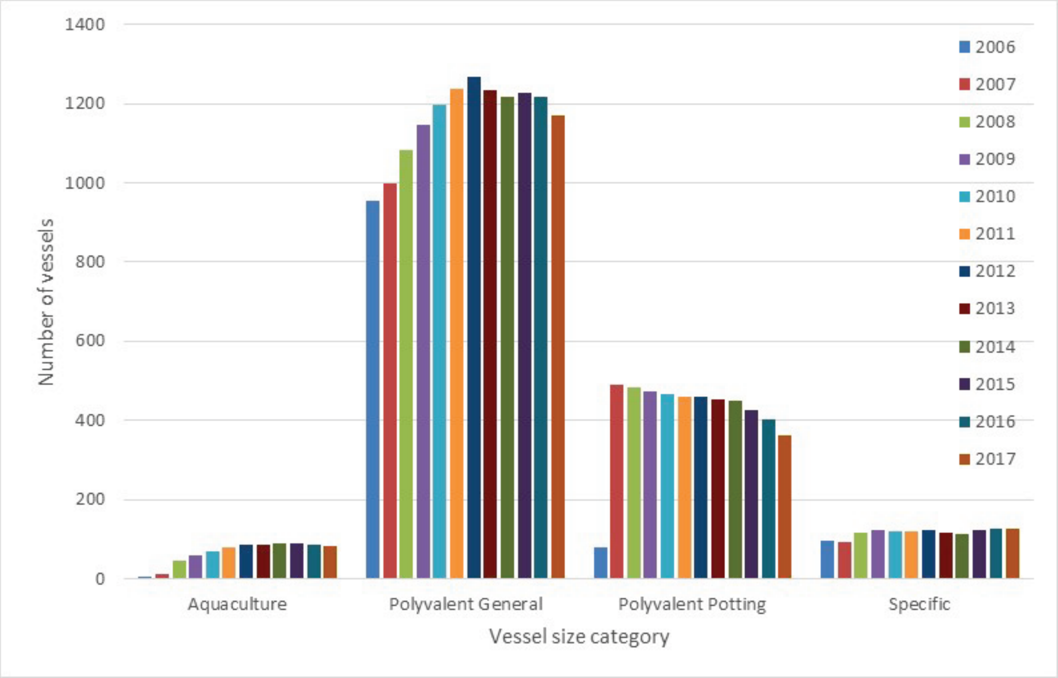


Figure 1. Annual trends in the number of fishing vessels under 13 m in length in four fleet segments 2006-2017.

3 Shellfish Landings 2004-2016

Annual landings of crustaceans and bivalves, excluding *Nephrops* and wild blue mussel (*Mytilus*) seed, which is re-laid for on-growing, during the period 2004-2016, varied from a high of 29,000 tonnes in 2004 to a low of 13,790 in 2009 (Table 3).

Landings data for some species (lobster, periwinkle) in recent years show unexpected changes in volumes relative to say 2004 levels. Spider crab in 2012 was substantially higher than in any previous years. Brown crab landings in 2012 were less than half of their value in 2004 but increased substantially in 2016. Lobster landings in 2012 were approximately 30% of 2011 landings. Although landings can obviously increase or decline due to changes in fishing effort or catch rates the scale of change in some species, in fisheries that are known to have stable or increasing effort and where catch rate indicators are stable, is contradictory. Other sources of information from industry questionnaires also indicate significant differences between official landings and landings derived from estimates of catch rates, annual individual vessel landings, days at sea and individual vessel fishing effort.

A number of species such as lobster, periwinkle, native oyster and shrimp are targeted by vessels under 10 m in length. As these vessels do not report landings capturing these data is difficult due to the large number of vessels and the small daily consignments involved. Improved tracking of landings by vessels under 10 m would significantly improve data on total landings for a number of species and give a more accurate picture of the economic value of the shellfisheries sector.

Landings data for certain species that are subject to management plans (cockle), that are managed locally (oysters) or where SFPA have analysed gatherers dockets and consignment data to buyers (razor clams) are accurate.

In 2016 the total volume of shellfish landed increased significantly compared to previous years and was the second highest year on record. This increase was due mainly to higher landings of brown crab and whelk which increased by approximately 4,000 tonnes and 3,000 tonnes, respectively, over 2015. Total value of shellfish, excluding mussel and *Nephrops* in 2016 was over €56million.

Table 3. Estimates of annual landings (tonnes) and value (€) of crustacean and bivalve shellfish (excl. prawns and mussels) into Ireland 2004-2016 (source: Logbook declarations and estimates for vessels under 10m). Unit value (per kilo) is from sales note data or other sources. Figures in bold from www.sfpa.ie.

Scientific Name	Common name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Unit Price 2016	Value 2016
Cancer pagurus	Edible crab	14,217	9,527	10,827	9,251	7,640	6,614	8,622	6,372	6,691	**6,510**	***7,105***	**7,229**	**11,181**	€1.61	€18,001,410
Pecten maximus	King Scallop	2,471	1,277	742	953	1,322	1,325	1,950	2,203	2,701	3,154	2,834	2,209	2,464	€4.37	€10,767,680
Homarus gammarus	Lobster	856	635	625	308	498	431	477	735	249	374	*456*	371	398	€14.72	€5,858,560
Littorina littorea	Periwinkle	1,674	1,139	1,210	609	1,141	1,103	1,280	64	103	218	1,135	17	3	€2.00	€5,200
Buccinum undatum	Whelk	7,589	4,151	3,144	3,635	1,947	2,239	2,976	2,828	3,440	2,660	2,172	3,296	**6,292**	€1.49	€9,375,080
Palaemon serratus	Shrimp	405	151	319	325	180	228	135	111	152	157	*301*	250	361	€13.15	€4,747,150
Ostrea edulis	Native oyster	543	94	233	291	88	327	349	100	*100*	214	265	153	190	*€4.00*	€760,000
Aequipecten opercularis	Queen scallop	110	75	172	26	4		748	1,002	1,479	285	*100*	31	205	€1.04	€213,200
Necora puber	Velvet crab	291	245	281	142	268	205	342	160	168	365	*283*	406	289	€2.12	€612,680
Spisula	Surf clam	28		26	14	55	150	*162*	*73*	15	37	*67*	48	51	€3.00	€153,000
Maja brachydactyla	Spider crab	180	141	153	70	153	443	415	290	818	229	*210*	190	108	€1.42	€153,360
Palinurus elephas	Crayfish	80	30	34	16	18	28	30	25	33	34	*23*	25	8	€33.56	€268,480
Ensis spp	Razor clams	400	404	547	356	451	293	410	473	428	723	1,040	840	927	€6.21	€5,756,670
Chaceon affinis	Red crab	214	294	152	83	44	105	91	106	0	0	*0*	33	6	€1.30	€7,800
Carcinus maenas	Shore crab	268	27	46	91	72	244	129	74	253	31	*49*	30	165	€0.53	€87,450
Cerastoderma edule	Cockle	207	107	7	643	9	173	5	401	400	374	*3*	0	321	€1.85	€593,850
Veneridae	Venus clam		217	4												€0
Total		29,533	18,514	18,522	16,813	13,890	13,908	18,121	15,017	17,030	15,365	16,043	15,128	22,969		€57,361,570

4 Razor clam (*Ensis siliqua and Ensis arcuatus*)

4.1 Management advice

All commercially exploited razor clam stocks are assessed by survey which provide estimates of biomass and size structure. Weekly TACs apply to vessels in the north and south Irish Sea. All vessels report VMS data. Voluntary TAC agreements are in place for Clifden Bay and Iniskea Island based on advisory 20-30% harvest rates although these are subject to revision.

Surveys of unexploited razor clam beds on the west coast indicate potential for limited fisheries. Protocols for the opening and management of potential new razor clam fisheries have been established. All new fisheries will open under management plans including annual TACs and other quota allocation and effort restriction measures.

The north Irish Sea fishery expanded significantly in the period 2011-2017. All indicators (daily landings per vessel, catch per hour) show significant and persistent declines over time. A survey in 2017 indicated a biomass of 6,841 tonnes and an approximate annual exploitation rate of 10%. Large size classes are being depleted and the fishery is increasingly reliant on small and less valuable clams due to growth overfishing. Spawning per recruit output has declined over time as the average size and prevalence of larger clams has declined Weekly quotas have not stabilised landings or effort which continue to increase although landings and effort in 2016 and 2017 were similar. The number of vessels in the fishery increased from 49 in 2015 to 73 in 2016 and 2017. Depletion corrected average catch assessment indicates that landings should be significantly reduced from current levels; current estimates, with some assumptions, suggest a reduction to 300 tonnes per annum.

The south Irish Sea fishery opened in 2010 and expanded quickly to 2013. Annual landings declined from 2013-2016. The Rosslare fishery was closed by voluntary agreement in 2017 due to low biomass of commercial clams. New management measures to reduce harvest rates are required to avoid growth overfishing.

Many razor clam fisheries or potential fisheries occur within or close to Natura 2000 sites. The conservation objectives for species and habitats in these areas should be integrated into Razor clam fishery management plans.

4.2 Issues relevant to the assessment of the razor clam fishery

Razor clams (*Ensis siliqua*) occur along the east coast of Ireland in mud and muddy sand sediments from Dundalk to Dublin and from Cahore to Rosslare and in numerous areas along the west coast. A second species, *Ensis arcuatus*, is abundant in clean sand substrates on the west coast. Both species may occur in the same area. The distribution is currently known from the commercial fishery which operates in water depths of 4-14m and from surveys where there are no fisheries. Fishing depth is limited because of the fishing method which uses hydraulically pressurised water to fluidise sediments in front of the dredge. The distribution of razor clams may extend to deeper water outside of the range of the fishery as the species occurs at depths of up to 50 m. However, there is no evidence that significant biomass occurs outside of those areas already fished.

The efficiency of the hydraulic dredge used in razor clam fisheries in the UK has been measured at 90%. The dredge, therefore, is very efficient at removing organisms in the dredge track. This is in contrast to non-hydraulic dredges used in other bivalve fisheries such as scallop and oyster where dredge efficiency may be in the region of 10-35%. Discard mortality rates are unknown but may be significant given that damage can be observed on the shell of discarded fish and unobserved shell damage may occur at the dredge head.

Ensis siliqua is slow growing, reaches a maximum shell length of approximately 220 mm and has relatively low productivity. The apparent resilience to date of the species in areas subject to persistent fishing by highly efficient gears may possibly be explained by immigration of juvenile and adult razor clams from areas outside of the fishery. Some evidence of size stratification by depth has been shown in Wales and given the known mobility of the species suggests that post settlement movement and recruitment into fished areas may occur. *Ensis arcuatus* is faster growing, occurs in high densities and reaches a smaller maximum size than *E. siliqua*.

Physical disturbance of sediments and removal of *Ensis* by the fishery potentially alters the bivalve species composition and generally the faunal communities in benthic habitats. In shallow waters changes in the abundance and species composition of bivalves may have a negative effect on diving seaducks (Common Scoter) that feed on bivalves. This species is designated under the Birds Directive in both Dundalk SPA in Louth and Raven SPA in Wexford. The fishery may also result in changes to habitat due to the deep physical disturbance caused by the hydraulic dredging process.

4.3 Management Units

Stock structure is unknown. Larval dispersal and movement of juveniles and possibly adults suggests that the stock structure is relatively open along the east coast of the north Irish Sea and that individual beds are unlikely to be self-recruiting. Fishing is continuous from north Dundalk Bay to Malahide. Stocks in the south Irish Sea are likely to be separate to that north of Dublin given the different hydrodynamic and tidal regimes in the two areas.

Other isolated stocks occur in many locations on the south and west coasts. Fisheries occur in Clifden Bay and at the Iniskea Islands in Mayo.

4.4 Management measures

New management measures were introduced for the Rosslare – Cahore fishery in December 2014. These include a MLS increase from 100 mm to 130 mm, fishing hours from 07:00 to 19:00, 2.5 tonne quota per vessel per week (currently 2,000 kg), 1 dredge per vessel not to exceed 122 cm width and with bar spacing not less than 10 mm, prior notice of intention to fish and advance notice of landing, mandatory submission of gatherers docket information on landings, date and location of fishing, a requirement to transmit GPS position of the vessel on a 1 minute frequency and a defined fishing area to minimise overlap with Natura 2000 sites.

In the north Irish Sea the weekly vessel TAC is 600 kgs (from Jan 1st 2016) with a prohibition on landing on Sundays (SI 588/2015). The fishery is closed in June during the spawning season. The industry have proposed that the minimum landing size should increase to 125 mm in 2018.

Fisheries on the west coast have voluntary TAC arrangements in place based on survey data.

All vessels fishing for Razor clams must have a functioning VMS system on board and report GPS position at defined frequencies. Only 1 class of production area (A,B,C) can be fished during a fishing trip (SI 206/2015).

4.5 North Irish Sea

4.5.1 Landings

The fishery occurs close to the coast in shallow sub-tidal waters along the east coast from Dundalk south to Malahide (**Figure 2**).

Landings from the north Irish Sea in 2016 and 2017 were the highest on record at 887 and 898 (provisional) tonnes respectively. Seventy three vessels fished in 2016 and 2017 compared to 49 in 2015 and 43 in 2014 (Figure 3).

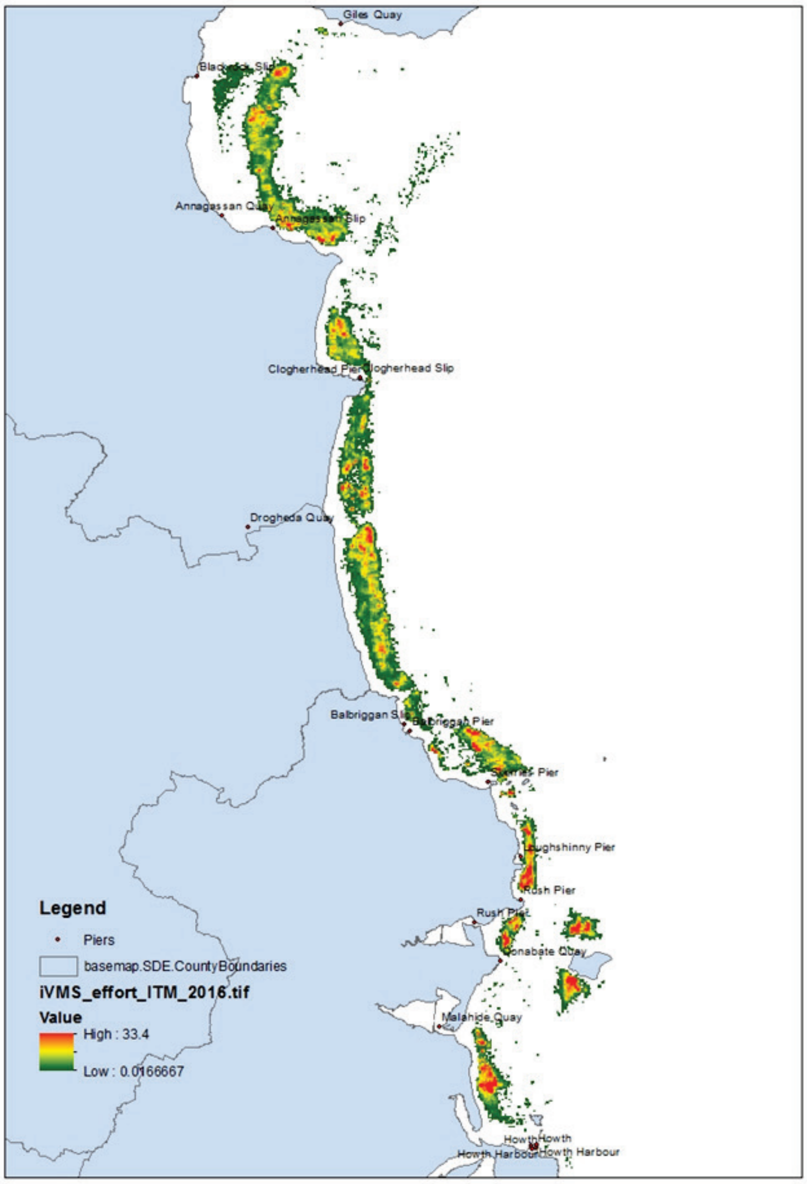


Figure 2. Distribution of fishing for razor clams in the north Irish Sea in 2016 from iVMS data.

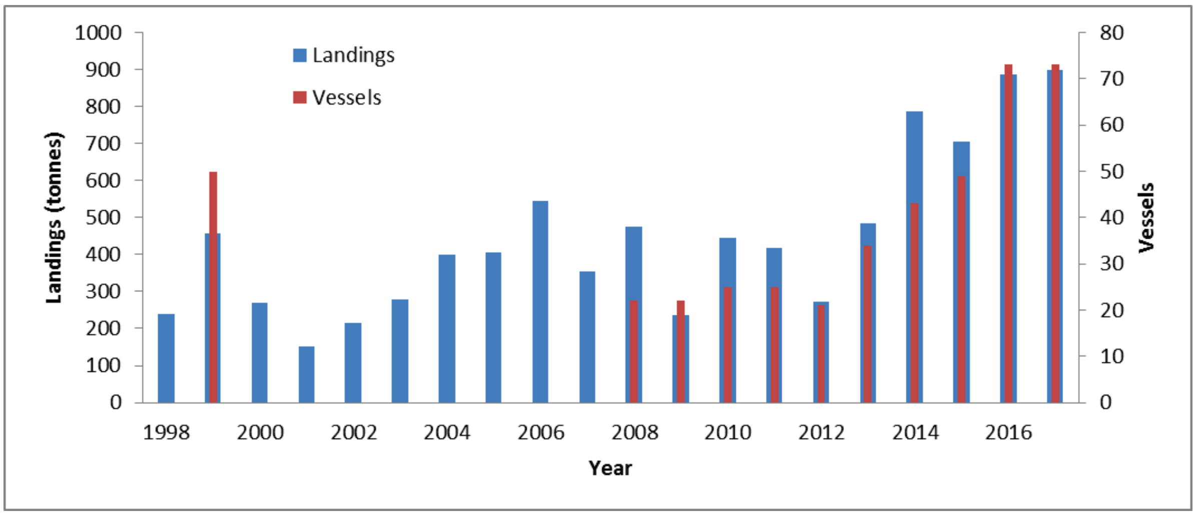


Figure 3. Annual landings of *Ensis siliqua* in the north Irish sea (NIS) 1998-2017 sourced from SFPA logbook and port report data and shellfish gatherers data for vessels under 10 m in length. The number of vessels landing razor clams each year is shown for 1999 and from 2008 - 2017.

4.5.2 Survey 2017

A comprehensive survey encompassing all of the areas which are commercially fished for Razor clams was completed in the north Irish Sea in June 2017. The survey was designed using the 2016 iVMS data which showed the level of fishing effort on a 100 square meter grid. This fishing effort was regarded as a proxy for the abundance of razor clams i.e. most fishing effort is expected to occur where clams are more abundant. For operational purposes and to assign stations to each of the 4 survey vessels, the survey domain, which extended from north Dundalk Bay south to Malahide and Lambay, was divided into 4 areas with approximately 200 stations in each area. Within each area, 4 iVMS effort strata of the same surface area where defined, and 50 stations were randomly assigned within each strata, to ensure an even distribution of randomly assigned grid cells across the range of efforts. The survey was mostly completed over a 5 day period but with some delays due to poor weather which extended the survey into a second week in some areas.

Biomass at each station was estimated based on density (number of individuals caught per meter squared towed area) multiplied by the mean individual weight calculated from the size distribution at the station and a weight-length relationship. Biomass was then interpolated over a 100 m x 100 m grid using ordinary kriging on log(biomass). Total biomass was then estimated as the sum of mean estimated biomass, using a geostatistical (kriging) model, raised to the surface area of the cells. Ninety-five percent confidence intervals were estimated based upon 250 random realisations of the modelled biomass using conditional Gaussian simulations. This preserves the spatial structure in the biomass, as described by variograms which modelled the spatial autocorrelation and spatial structure in the survey data or how density changes relative to distance between stations.

4.5.2.1 Size and weight distribution

The modal shell size was 130 mm with a second smaller mode at 180 mm. Approximately 64% of clams were less than 160 mm. Clams less than 100 mm were poorly represented in the survey. Although much of this might be due to gear selectivity the absence of smaller clams even in areas where bulk catch was high suggests weak settlement and recruitment in 2016 and 2015. The modal weight was 25 g representing the size mode at 130 mm (Figure 4).

The size distribution reflects both the exploitation rate, growth, mortality and recruitment history of the stock. Unexploited stocks surveyed on the west coast in 2016 show an accumulation of larger size classes typical of long lived species with relatively low natural mortality rates. The size distribution of heavily exploited and economically collapsed stocks, such as the Rosslare Bay stock, is dominated by smaller clams under the commercial size.

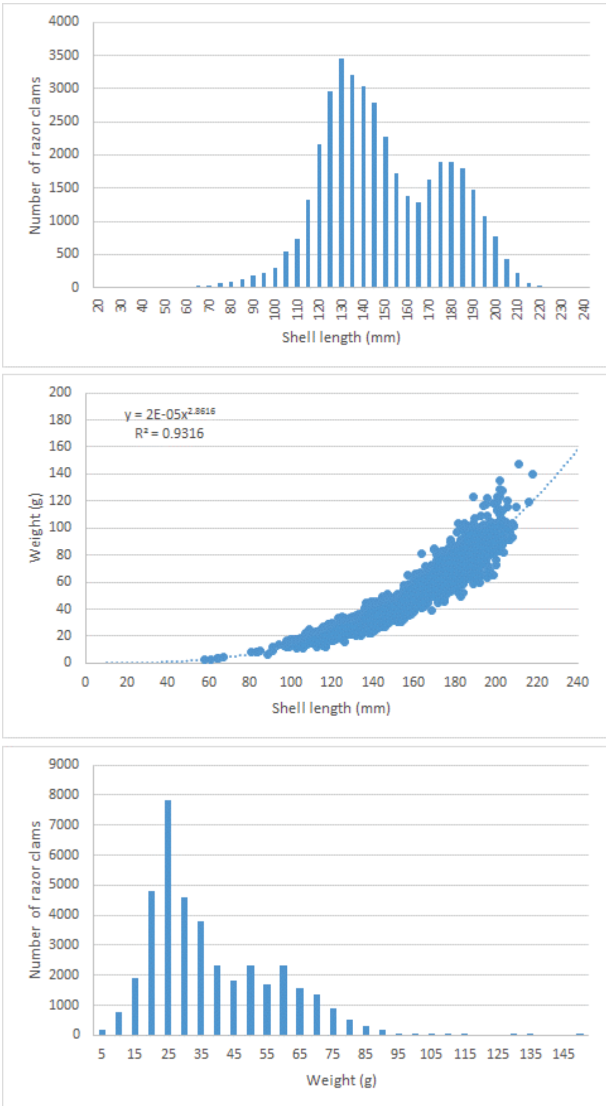


Figure 4. Size distribution, length weight relationship and weight distribution for razor clams in the survey.

4.5.2.2 Biomass

The total biomass in the June 2017 survey was 6,841 tonnes (95% confidence interval: 6,424-7,261 tonnes). Approximately half of this was in medium and high grades over 160 mm (Table 4). Density was lower in the northern part of the survey area in Dundalk Bay, particularly north of the Bay, south of Clogherhead and north of Drogheda. Densities were higher in Skerries and Malahide. These latter areas have been closed to fishing for periods of time in the last number of years. Larger clams over 180 mm were more common in Dundalk bay and Gormanstown. Smaller clams were more abundant off Skerries and Malahide (Figure 5).

The monetary value of the standing stock, estimated from the price per grade applied to the size structure data from the survey was €34.9 million. About €23.6 million of this (68%) was in grades over 160 mm although just 54% of the stock biomass was over 160 mm (Figure 5).

Table 4. Mean, median and 95% confidence intervals for the total biomass of *Ensis siliqua* and disaggregated to different size classes. *from a two step geostatistical model: presence/absence + abundance|presence

	Mean	Median	Lower 95% C.I.	Upper 95% C.I.
Biomass Total	6,841	6,838	6,424	7,261
Biomass >100 mm	6,797	6,788	6,348	7,205
Biomass >125 mm	6,211	6,190	5,864	6,620
Biomass >130 mm	5,910	5,902	5,584	6,238
Biomass >160 mm	3,677	3,683	3,445	3,882
Biomass >180 mm	2,055	2,056	1,915	2,193
Biomass >200mm*	351	350	307	400

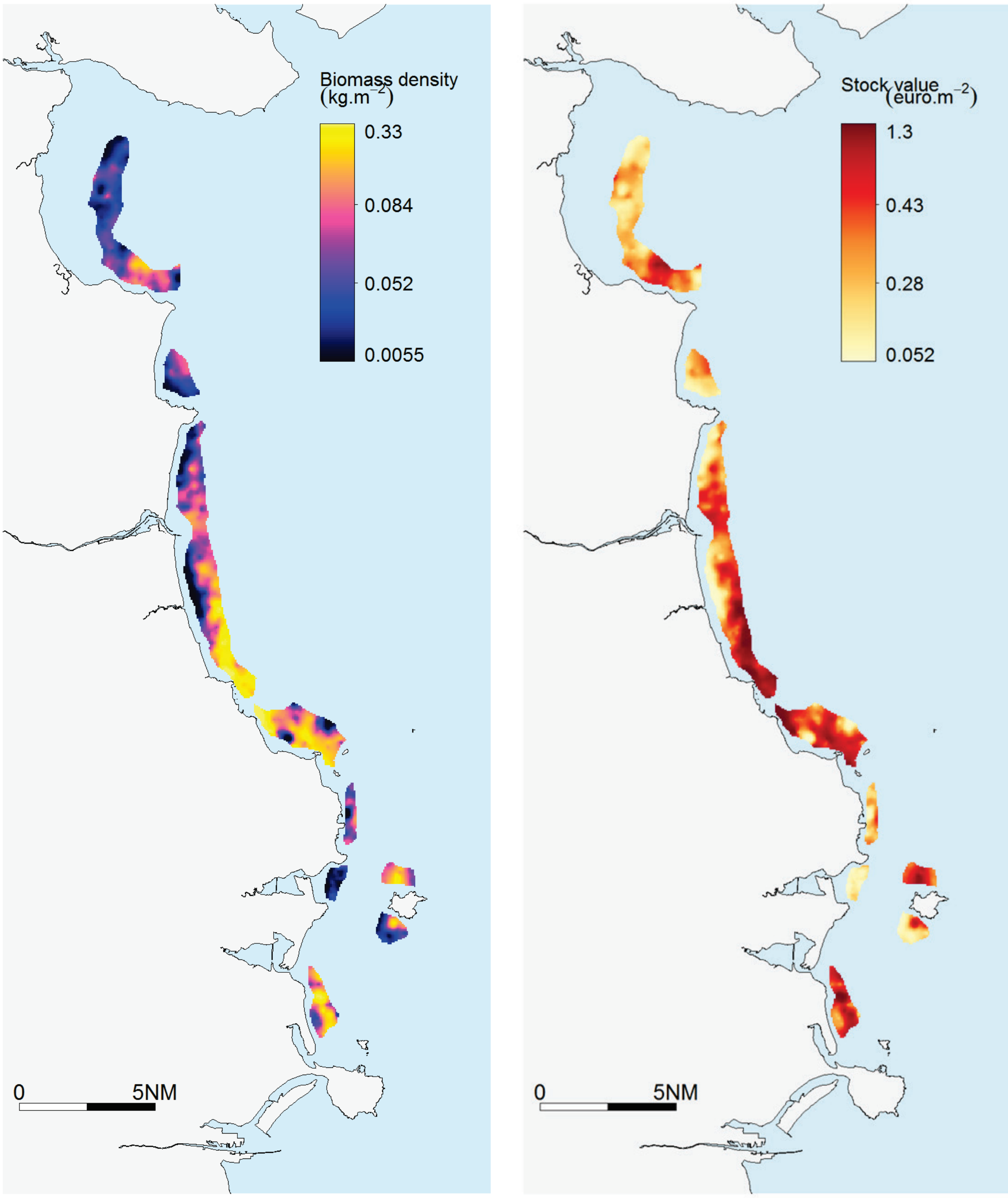


Figure 5. Distribution of biomass and value (Euros per meter square) of razor clams in the north Irish Sea June 2017. Value is based on market price structure per size grade and the estimated biomass of each grade.

4.5.3 Stock biomass indicators

Stock biomass indicators (LPUE kgs.day^{-1}, LPUE kgs.hr^{-1}) were estimated from data on consignments to buyers in 2013-2017 and from sentinel vessels 2009-2016. The indicators may be increasingly biased in recent years due to high grading at sea given that the market price increases significantly with size grade and Skippers will try and maximise the value of the weekly quota of 600kgs.

Daily consignments (kgs.day^{-1}) declined from 300 kgs.day^{-1} in early 2013 to 200 by end of 2016 and 186 in Q4 of 2017 (Figure 6). Daily landings reported in SVP logbooks showed a monthly decline of 2.7kgs.day^{-1} in daily landings. Daily landings were between 400-500kgs in 2009-2012 and close to 200 kgs in 2015 and 2016 (Figure 7).

The sentinel vessel data provides a more precise indicator of stock biomass in LPUE per hour of dredging. This varied from 30-40 kgs.hr^{-1} in 2009-2011, declined to 20 kgs.hr^{-1} in 2014-2015 and was approximately 17 kgs.hr^{-1} in 2016 (Figure 8).

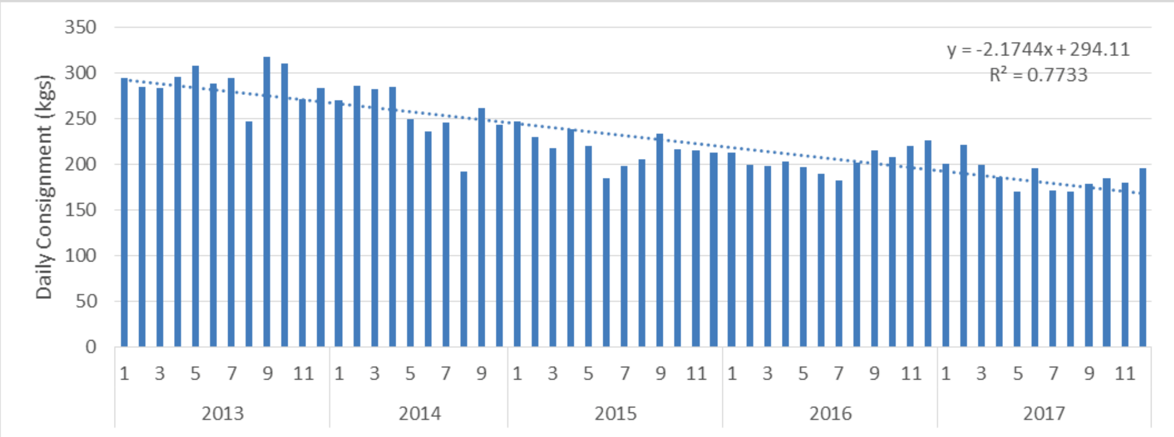


Figure 6. Average daily consignments (kgs) per month recorded in gatherers dockets 2013-2017 showing a rate of decline of 2 kg per day per month in consignment volume. Source: SFPA

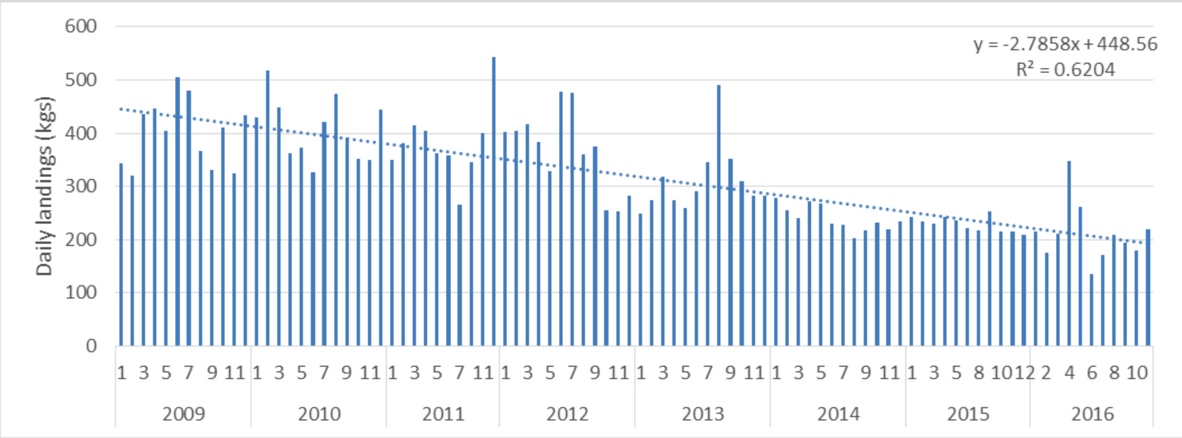


Figure 7. Monthly trends in landings per day by sentinel vessels reporting between 2009 and 2016.

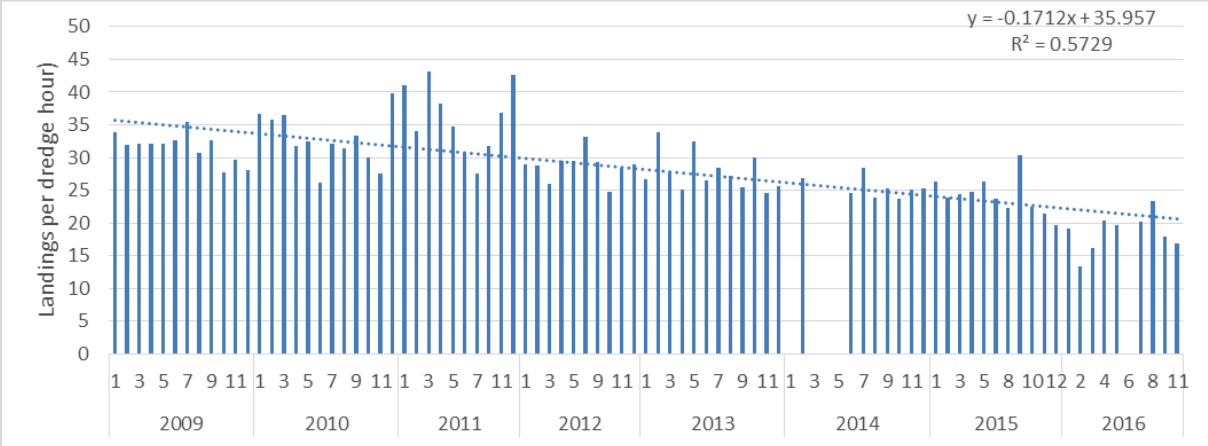


Figure 8. Monthly trends in landings per dredge hour by sentinel vessels reporting between 2009 and 2016 in the North Irish Sea.

4.5.4 Depletion corrected catch advice

Where no depletion has occurred during a period of years of the fishery then the average catch during that period could be said to be sustainable and the longer the time series where this condition stands then the higher degree of certainty that this is the case. Where depletion has occurred then the average catch is not sustainable and should be discounted by some proportion, or corrected, for the annual 'windfall' or for landings that resulted in the depletion. This is the depletion corrected average catch (DCAC). After such a correction is done the remaining catch is that which should produce sustainable yields (Y_{sust}) in the long term

$$Y_{sust} = \frac{\sum C}{n + {}^{W}/_{Y_{pot}}}$$

where C is the cumulative catch during (n) years, W is the windfall catch and Y_{pot} is the potential yield defined as $XcMB_0$ where B_0 is the initial biomass, M is natural mortality, X is the proportion of B_0 that results in B_{msy} (empirically from general stock recruit relationships in fish stocks) and c is a tuning adjustment to correct for the assumption that F_{msy} = M. In effect the ratio of windfall catch to potential catch (W/Y_{pot}) = Δ/XcM where Δ is the degree to which biomass has been depleted during the time series. Where there has not been any depletion then Δ=0 and W/Y_{pot} = 0 and the sustainable catch is simply the average catch during the time series.

Depletion Corrected Average Catch (DCAC) estimates were based on B_o (or landings per unit effort at assumed unexploited biomass; LPUE B_o) estimated from Fahy 2001 for data collected in 1999. At this point the stock may already have been at 60% of its true B_o.

There are some mitigating issues which may render this advice overly conservative. Landings data may be under estimated in the past, trends in indicators may be influenced by market conditions and fishing strategies such as high grading and some unexploited stock may occur outside the fishing area. Selectivity patterns, determined mainly by the bar spacing on the dredge, are assumed to have been constant over time.

Table 5. DCAC depletion corrected average catch estimates for Razor clams in the Irish Sea.

Parameter	Value
Sustainable yield (Mean)	299 tonnes
Sustainable yield (Median)	299 tonnes
95% confidence upr	341 tonnes
95% confidence lower	251 tonnes

4.5.5 Spawner per recruit

The size distributions of razor stocks change, becoming increasingly truncated at large sizes, as the rate of exploitation increases. Theoretically there is a size distribution and a rate of fishing that would result in sustained average maximum sustainable yield (MSY). The spawning and recruitment potential (represented here by the spawning potential ratio; SPR) for the stock is also affected by changes in the size distribution, given that maturity and selectivity are size related, and by overall abundance of different size classes. In Irish Sea fisheries there have been changes over time in size (and grade) composition. In the extreme case, representing an economically collapsed fishery in Rosslare Bay, the stock is dominated by small clams under the commercial size. Size distributions in the North Irish Sea in 2000 had higher proportions of larger clams than distributions in more recent years. To date, even in Rosslare, however, there is no evidence of declines in recruitment suggesting that relatively low spawning stock biomass can sustain recruitment or that these fished areas may be supplemented by recruitment from outside.

Time series of SPR for the Razor clam stock in the North Irish Sea shows a general declining trend and are well below the estimated optimum MSY reference point of 0.3 indicating that the stock has become increasingly overfished (Figure 9).

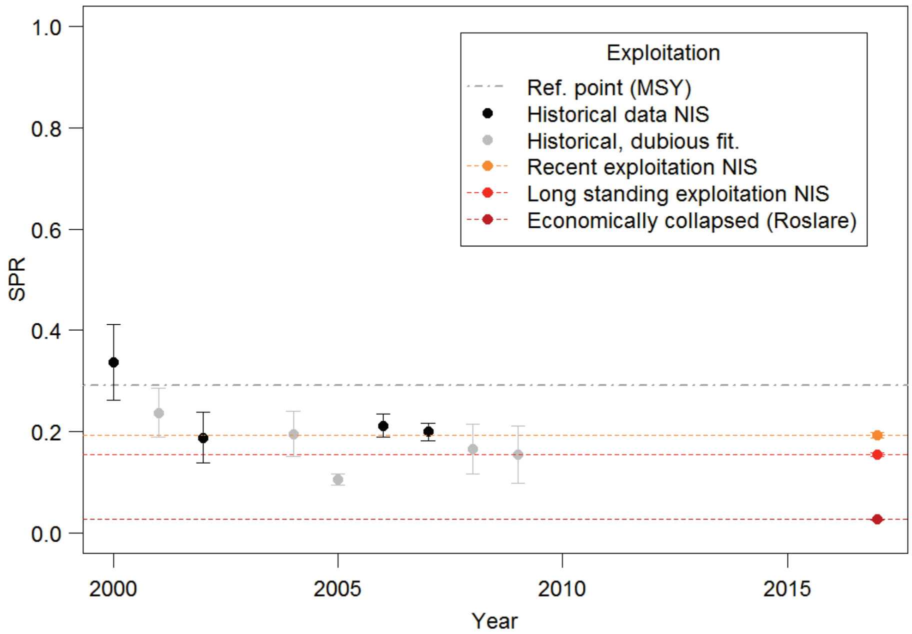


Figure 9. Spawner per recruit (SPR) estimates for recently exploited areas, areas which have been fished for longer periods of time and for economically collapsed stocks relative to an SPR reference point of 0.3 (estimated assuming that 80% of maximum recruitment occurs at $0.2B_o$ where B_0 is the unexploited biomass)

4.5.6 Economic viability of the fishery

Prices of Razor clams per kilogram increased from an average of €2.21 in 2010 to €6.20 in 2016 (Table 6). Price is related to grade or shell length and varies from €3.50 for clams less than 160 mm shell length to €9.00 for clams over 200 mm shell length. Prices in SVP logbook data are provided as averages and are not disaggregated to grade. The market incentivises fishing for medium and large grade clams. Given the individual weekly quota of 600 kgs per vessel this price structure may result in high grading at sea in order to maximise the value of the weekly quota. This also increases fishing costs and time at sea however and is only cost effective to a degree.

Other than labour costs diesel is the main operating cost. Other costs have not been estimated at this point and the cost:earnings ratio is not fully known. Daily fuel costs increased from 2010-2012 and declined from 2012-2016 (Table 6). Net value of clams caught per hr spent at sea increased from 2011-2015 and declined in 2016.

Profitability declines with declining catch rates because fishing costs to take the weekly quota increases (Figure 10). In 2017 the net value of the quota, estimated from the size structure of the stock from the 2017 survey and sample price data and allowing for certain costs and minimum wage payment to one member of crew, was approximately €2,000. The availability and catch rate of large clams has declined and is expected to continue to decline unless overall exploitation rate is reduced. This will further erode the value of the quota either because the unit price will be lower or fishing costs will increase if operators high grade in an attempt to maintain unit price.

Table 6. Annual trends in fuel costs, hrs at sea, price of clams, LPUE and net (of fuel) value of the catch between 2010 and 2015.

Year	Daily fuel cost	Diesel € per Litre	Hours at sea per day	Price of clams per kg	Kgs clams per dredge hour	Net value of daily landings	Net value per hour at sea
2010	€208	€0.65	13.2	€2.21	32.20	€881.16	
2011	€244	€0.80	17.1	€2.54	35.86	€940.35	€36.90
2012	€272	€0.92	14.2	€3.45	28.00	€1,002.83	€45.60
2013	€227	€0.88	14.7	€3.79	27.26	€1,052.00	€45.70
2014	€180	€0.79	12.9	€4.60	25.35	€1,059.94	€65.00
2015	€148	€0.73	12.6	€5.60	23.94	€1,288.19	€88.00
2016	€136	€0.60	13.4	€6.20	25.50	€1,213.60	€85.00

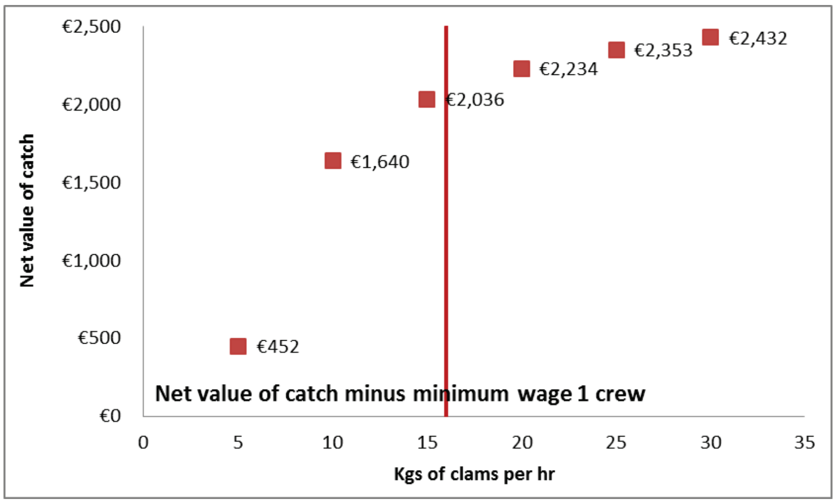


Figure 10. Net value of the weekly razor clam vessel quota of 600 kgs relative to catch rate per hour based on size / grade structure of the stock in 2017, payment of minimum wage to 1 crew and allowing for hourly fuel cost of €10.20 and other weekly operating costs of €233. The vertical red line indicates the catch rate per hour in 2016.

4.6 South Irish Sea

4.6.1 Landings

The fishery opened in quarter 4 of 2010 and landings increased annually up to 2013 to over 350 tonnes (Figure 11). Landings declined annually from 2013 to 176 tonnes in 2016. The fishery occurs mainly in Rosslare Bay and further north at Curracloe. The Rosslare Bay fishery was closed by voluntary agreement in 2017 due to decline in the availability of large clams. Approximately 12 vessels fish in the area but this number changes seasonally with some vessels moving to the north Irish Sea. The fishery occurs close to or overlaps with a number of SACs and SPAs. The SAC designations to the east of the fishery are mainly sandbanks. Common Scoter, which feeds sub-tidally on bivalves, is designated in the nearby Raven SPA.

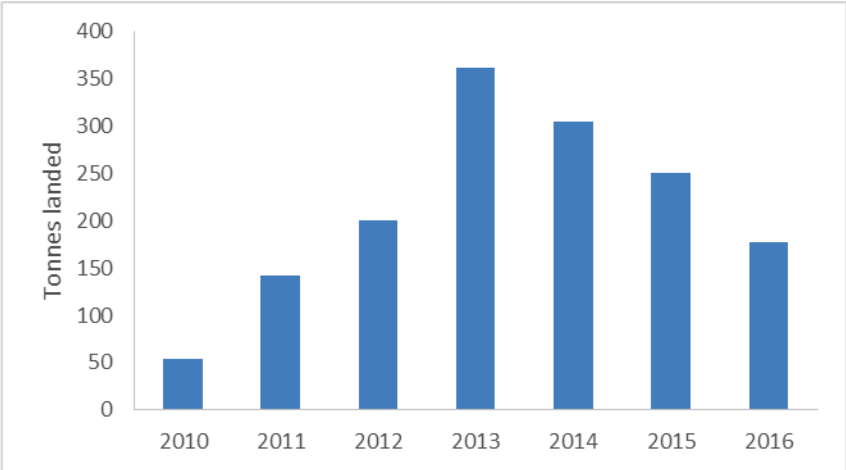


Figure 11. Annual landings estimated from a combination of logbook and gatherers data of razor clams in the south Irish Sea 2010-2016. The fishery opened in quarter 4 of 2010.

4.6.2 Survey 2017

A razor clam survey in Rosslare Bay was completed in May 2017. The survey area was determined by the iVMS data showing the distribution of fishing. The south east corner of the bed was, however, not surveyed. Biomass was estimated for different strata defined after the survey. The Curracloe stock north of Wexford Harbour was not surveyed.

Total biomass in Rosslare Bay was estimated to be 2,901±258 tonnes (Figure 12, Table 7). This was higher than the 2015 survey estimate of 800 tonnes due to significant recruitment in 2016. However, the biomass of commercial sized clams was lower in 2017.

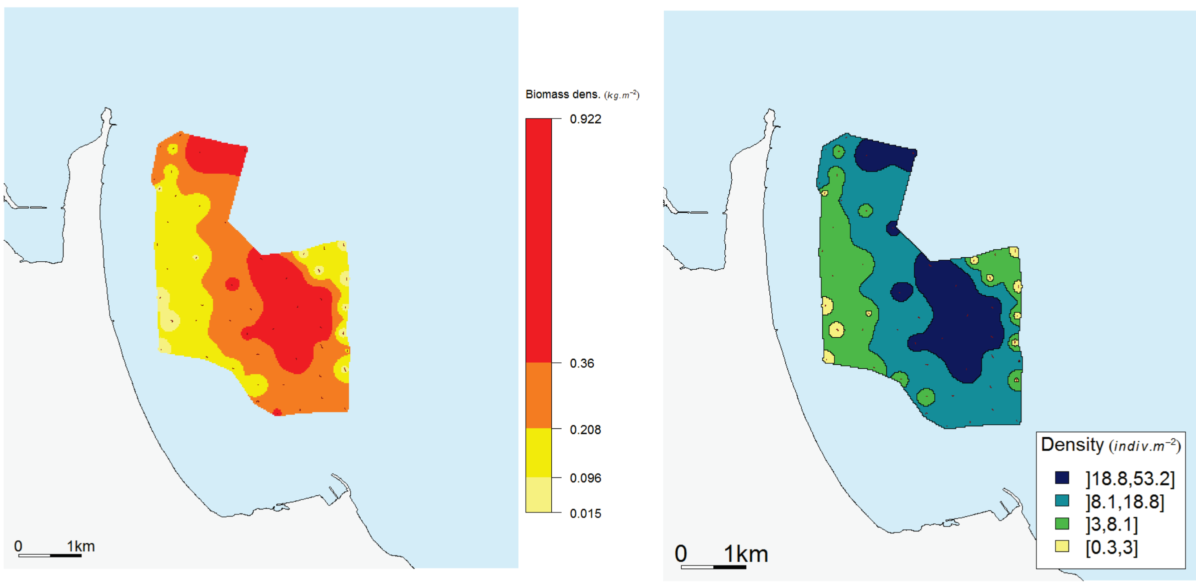


Figure 12. Distribution of biomass and density of razor clams in Rosslare Bay in May 2017.

Table 7. Biomass of razor clams (*Ensis siliqua*) in Rosslare Bay in May 2017.

Biomass stratum (kgs.m^{-2})	Area	Biomass	dBiomass
[0.015,0.096]	0.338	15.88	3.89
]0.096,0.208]	2.8028	408.86	50.33
]0.208,0.36]	3.6996	1110.21	93.23
]0.36,0.922]	2.2632	1366.34	235.89
Total	9.1036	2901.29	258.62

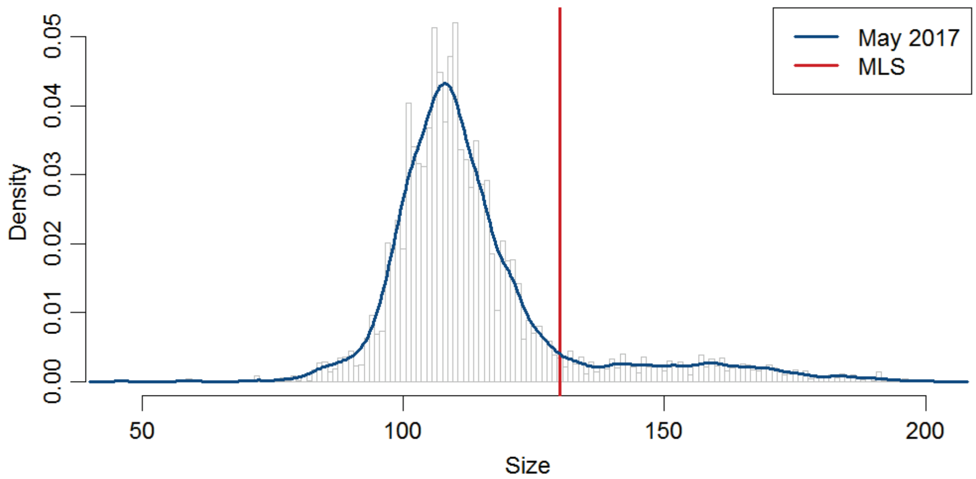


Figure 13. Size distribution of razor clams (*Ensis siliqua*) in Rosslare Bay in May 2017. The minimum landings size (130 mm) is shown.

4.7 Iniskea Islands

4.7.1 Landings

A small bed of razor clams south east of the Iniskea Islands supported a fishery in 2016 and 2017. Approximately 13 tonnes were landed in 2016 and 15 tonnes in 2017. Three vessels have fished the bed.

4.7.2 Surveys in 2016 and 2017

4.7.2.1 Biomass

Surveys were completed in July 2016 and April 2017 (Figure 14). The 2016 survey area was 0.12 km^2. Biomass of clams over 100 mm in the survey area was estimated at 39.7±7.2 tonnes. The survey in April 2017 covered an area of 0.477 km^2 and probably defines the full extent of the bed. Biomass was estimated to be 130±34 tonnes. In 2017 biomass (kg.m^{-2}) ranged from 0 in the deepest areas towards the south to 0.71 kg.m^{-2} in the west of the area. This was lower than in 2016 where highest biomass in the west of the survey area reached 2.2 kg.m^{-2}.

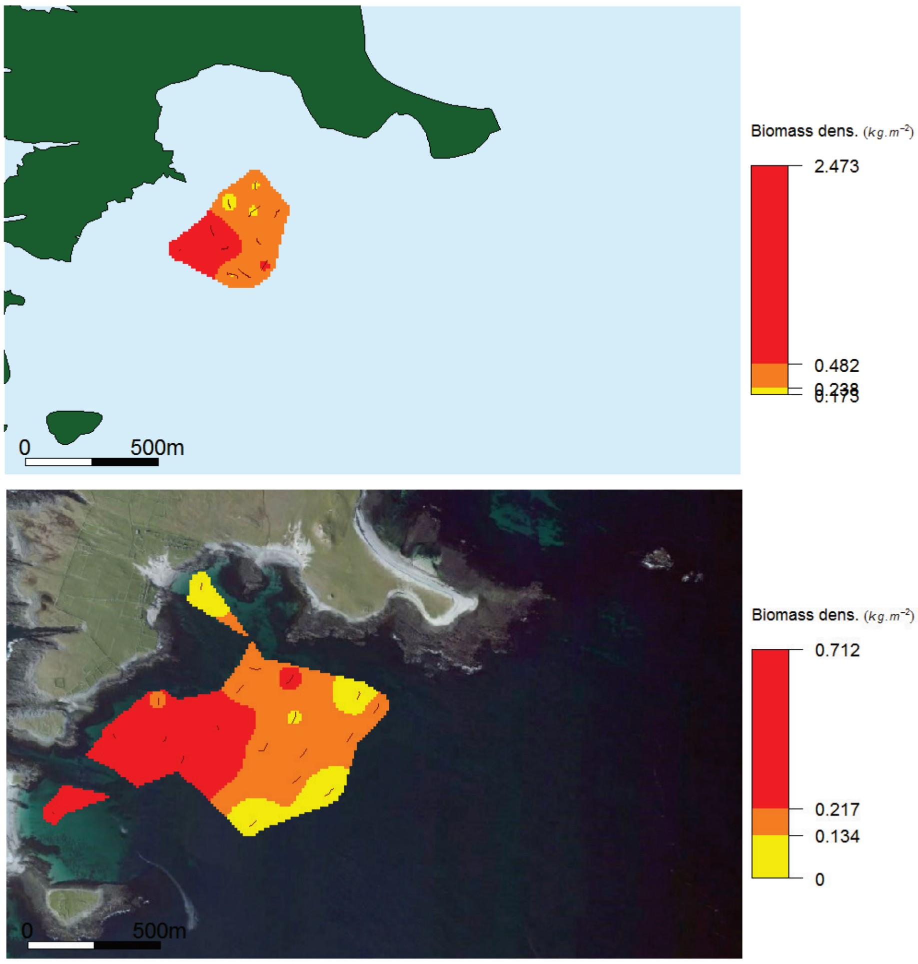


Figure 14. Distribution of biomass of *Ensis arcuatus* at the Iniskea Islands in July 2016 and April 2017.

4.7.2.2 Size distributions

Size distributions from survey data in 2015, 2016 and 2017 indicate annual recruitment events and stable size distribution of clams above the commercial size (Figure 15).

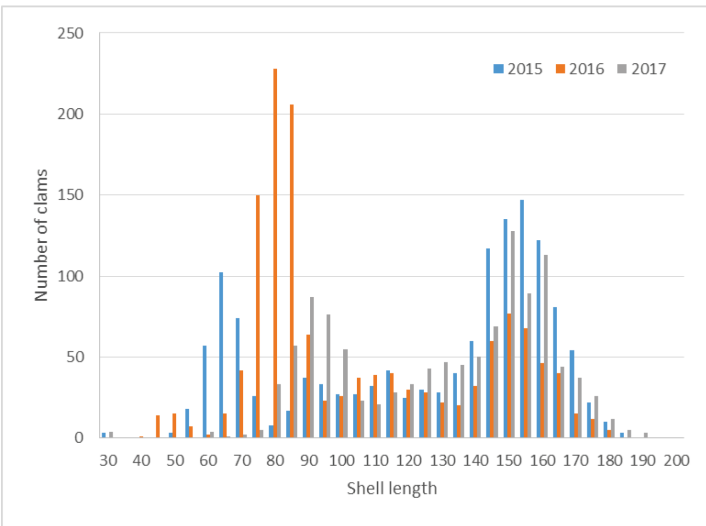


Figure 15. Size distribution of *Ensis arcuatus* at the Iniskea Islands in April 2017, July 2016 and October 2015

4.7.2.3 Exploitation rates

The fishery in February of 2016 did not result in depletion of catch rates. Significant depletion in catch rate of clams was observed in July-Aug 2017 (Figure 16). The depletion in catch suggests a pre-fishery biomass of 26 tonnes in the fished area compared to a biomass of 130 tonnes in the bigger area surveyed in April 2017. The reduced catch rates suggest an exploitation rate of 56% in 2017.

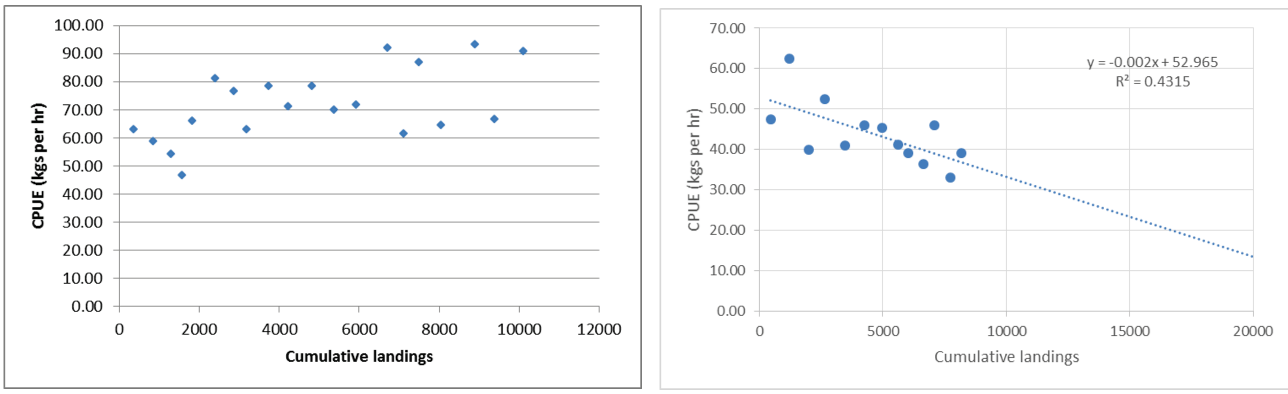


Figure 16. Catch rates of razor clams relative to cumulative landings during the fisheries in February 2016 (left) and July-August 2017 (right).

4.8 Clifden Bay

4.8.1 Landings

Clifden Bay has supported a razor clam fishery for over 30 years. Since 2010 annual landings have varied from 19-37 tonnes (Figure 17).

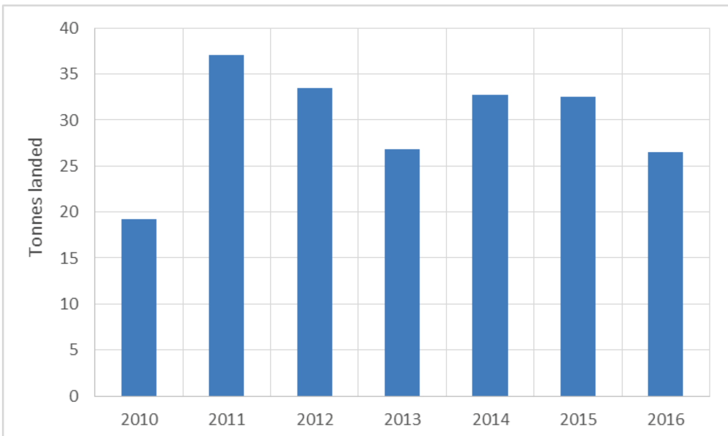


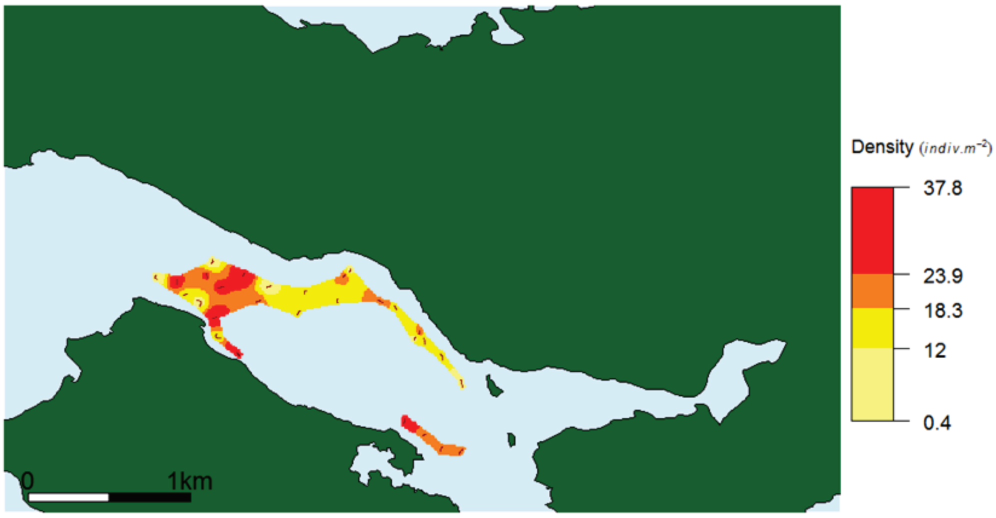
Figure 17. Annual landings of razor clams from Clifden Bay 2010-2016.

4.8.2 Surveys 2016 and 2017

4.8.2.1 Biomass

Surveys were completed in April/May 2016 and August 2017 (Figure 18, Figure 19). The survey area in 2016 was 0.34 km^2 in the inner Bay with a further 0.07 km^2 being surveyed in the outer Bay. In 2017 the area surveyed was 0.63 km^2 in the inner Bay and 0.08 km^2 in the outer Bay. The surveys encompass the distribution of the stock.

Biomass in the inner Bay was estimated to be 114 and 139 tonnes in 2016 and 2017 respectively. There were 32 tonnes in the outer Bay in 2017 compared to 57 tonnes in 2016.



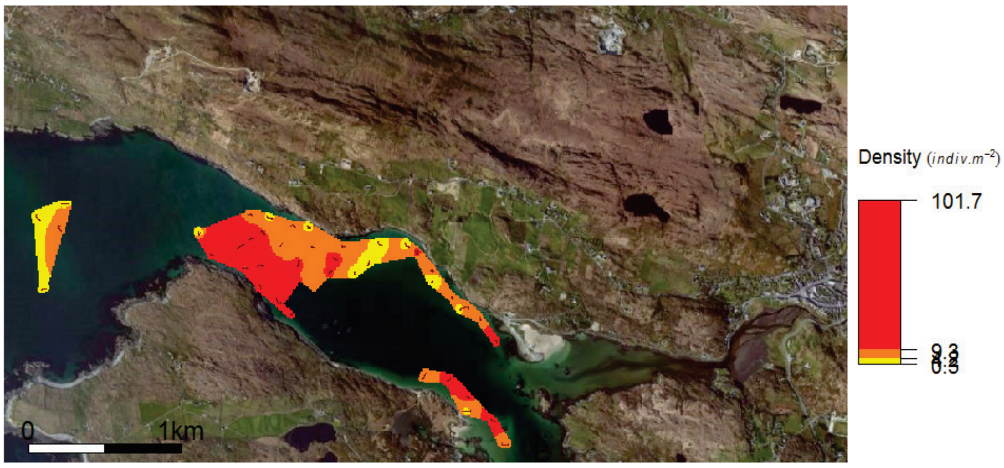


Figure 18. Distribution of density of razor clams in Clifden Bay in 2016 (top) and 2017 (bottom). A smaller area surveyed in the outer Bay is not shown in the 2016 biomass density map.

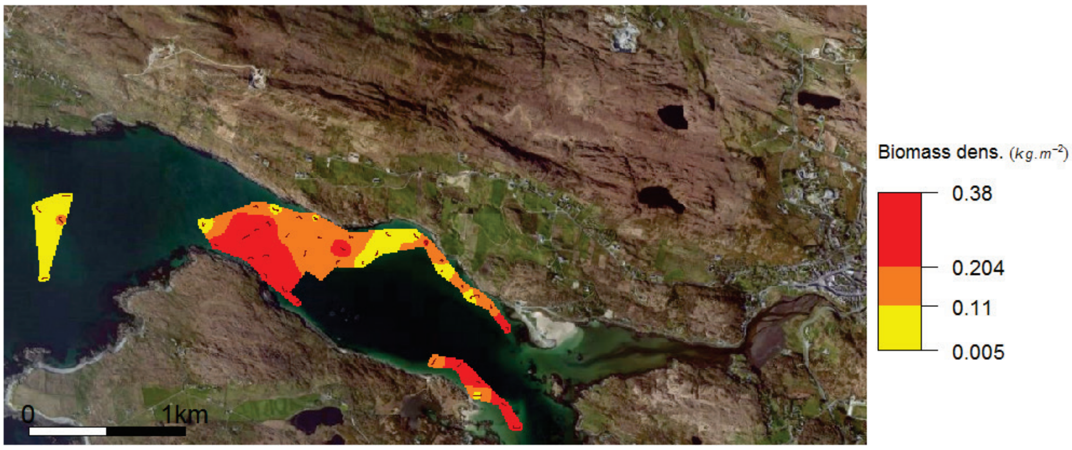


Figure 19. Distribution of biomass of razor clams in Clifden Bay in 2016 (top) and 2017 (bottom). A smaller area surveyed in the outer Bay is not shown in the 2016 biomass density map.

4.8.2.2 Size distribution

In April 2016 there were two modes in the size distribution; a pre-recruit class at about 75 mm and a second mode at 130-150 mm probably including a number of age classes. In August 2017 the main mode was just above 100 mm. However, there is no evidence of significant recruitment of smaller size classes in the 2017 survey (Figure 20).

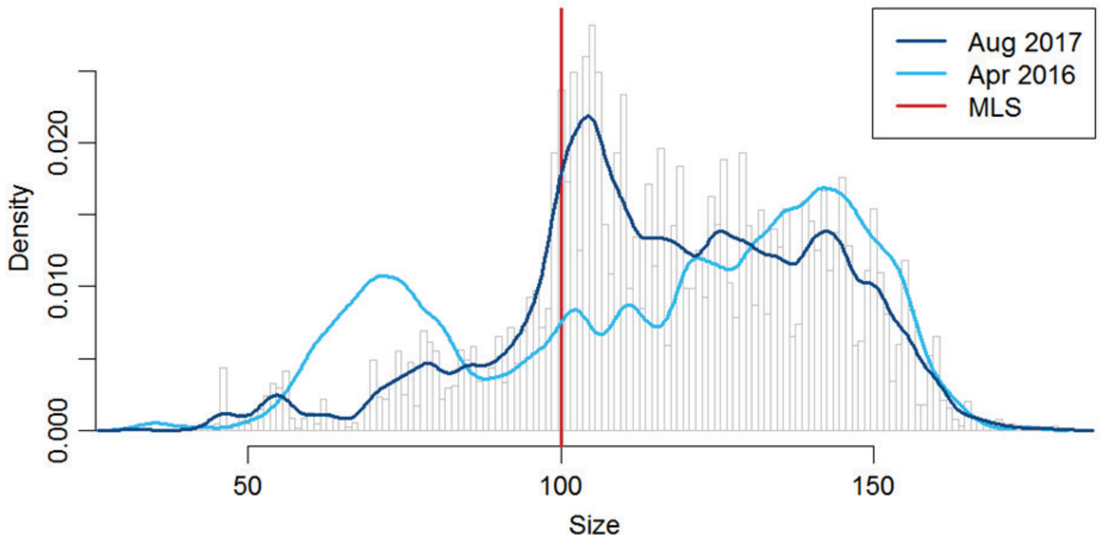


Figure 20. Size distribution of razor clams in Clifden Bay in 2016 and 2017. The minimum legal size (100 mm) is shown.

4.9 Unexploited razor clam stocks

Early in 2016 the putative distribution of razor clams off the west coast of Ireland was mapped based on information from fishermen who had fished these stocks in the 1990s and from other fishermen who had more recent knowledge of the location of commercially viable razor clam beds. Interest in fishing these stocks has increased recently because of high fishing pressure on stocks in the Irish Sea and strong market demand.

The Inshore Management Group (IMG), comprising the Department of Agriculture Food and Marine and Marine Agencies, identified a protocol by which razor clam stocks that had not been fished for a number of years could potentially be re-opened and fished sustainably. This protocol included provision for a preliminary assessment of stock distribution and biomass which could be used to prioritise areas for new fisheries based on economic potential and whether the stock existed within an existing classified production area for bivalve molluscs or not. To inform the protocol and the prioritisation of areas that could potentially be opened to fishing a number of razor clam surveys were completed during 2016. The surveys provide information on species composition (there are 3 species of *Ensis* in the survey data), spatial distribution, biomass, size composition and indications of age and growth. Preliminary and speculative annual TAC scenarios are indicated, based on harvest rates that are thought to be sustainable, in order for the authorities and industry to evaluate the benefits of opening these areas to fishing. The speculative TACs proposed will need to have a firmer basis and the stocks will need to be monitored annually if they are opened to fishing. A full report of these surveys is available at http://inshoreforums.ie/.

4.9.1 West Coast Surveys in 2016

Surveys were completed in areas shown in Table 8 and Figure 21. More than one area (razor clam bed) was surveyed in some locations. In inner Bantry Bay discrete areas in Bearhaven and in Adrigole Harbour were surveyed. In north west Donegal Gweedore Bay, Cruit Bay and Rutland sound were surveyed. A number of beds were sampled at the approaches to Killary Harbour, North and South shores of Ballinakill Bay and south and east of Inisbofin. Ten tows were taken east of Inisturk opportunistically by one of the survey vessels on passage. A total of 222 stations were sampled between April and November 2016.

Table 8. Locations of Razor clam surveys in 2016 and number of dredge tows taken per survey.

County	Location	Number of tows	Dredge type	Dredge width	Month
Cork	Bearhaven	33	Water jets	1m width	July
Cork	Adrigole Hbr	8	Water jets	1m width	July
Donegal	Gweedore Bay	23	Water jets	1m width	October
Donegal	Cruit Bay	10	Water jets	1m width	October
Donegal	Rutland Sound	53	Water jets	1m width	October
Galway	Ballinakill Bay	18	Water jets	1m width	September
Galway	Inisbofin	9	Water jets	1m width	September
Galway	Inisturk	10	Water jets	1m width	November
Galway	Killary Approaches	36	Water jets	1m width	October
Mayo	Broadhaven Bay	22	Water jets	1m width	July

Figure 21. Locations of razor clam surveys off the west coast of Ireland in 2016. Clifden Bay and Iniskea support fisheries. Other areas are unexploited.

Ensis arcuatus was the dominant species in all surveys other than in the approaches to Killary Harbour, comprising 94% by number and 91% by weight of all clams identified to species (Table 9). The total surveyed area was 8 km^2 and the total likely distribution area was 12 km^2.

Table 9. *Ensis* species composition in surveys by number and weight.

Species	Sample size		Proportion	
	Number	Weight	Number	Weight
Ensis arcuatus	33366	761	0.94	0.91
Ensis ensis	62		0.01	0.01
Ensis siliqua	2024	73	0.06	0.09
***Ensis* spp.**	4966	191	0.12	0.23
Total	40419	1025		

Nominal catches of *E. arcuatus* per 3-5 min tow ranged from 30-662 individuals and 1-13.7 kgs. Catches at Ballinakill Bay and Broadhaven Bay averaged 130 and 121 individuals per tow respectively. Lowest average catches of *E. arcuatus* occurred at Cruit Bay, Rutland sound and at the approaches to Killary (Table 10).

Table 10. Mean number and weight (kgs) of catch of *Ensis* spp. per 3-5 minute tow at survey locations.

Location	Mean Number per tow			Mean kgs per tow		
	E. arcuatus	*E. siliqua*	*Ensis* spp.	*E. arcuatus*	*E. siliqua*	*Ensis* spp.
Bearhaven			142.9			5.1
Adrigole Harbour			31.1			1.2
Gweedore Bay	81.6	11.6		2	0.6	
Cruit Bay	30.5	32.2		1.1	2	
Rutland Sound	46.9	5.3		1.3	0.3	
Ballinakill Bay	130.9	1.5		4	0.1	
Clifden Bay	298.4			7.4		
Turbot Island Clifden	662.1			13.7		
Inisbofin	244.9	3.2		7.7	0.3	
Inisturk						1.3
Killary Approaches	40.7	18.6		1.2	1.1	
Broadhaven Bay	121.9	20.3		4.2	0.1	
Iniskeas	593.2			9		

4.9.1 Biomass and possible TACs

Estimated biomass and annual possible TACs for each area are summarised in Table 11. A range of TAC possibilities are presented given the limited scope of the surveys, the uncertainty in the biomass estimates and assumed sustainable annual harvest rates of 20-30%. The lowest expected TAC was estimated as a harvest rate of 20% of the lower 95% confidence interval of the biomass estimated in the surveyed area. The likely value was based on a 25% harvest rate of the average biomass estimated from the survey area and the maximum expected TAC was calculated from the upper 95% confidence interval of the extrapolated area over which razor clams may be distributed beyond but contiguous with the surveyed area. All these estimates and the sustainable harvest rate, would need to be confirmed by more extensive surveys if the areas are opened to fisheries. Variation in dredge efficiency has not been accounted for in the estimates.

Except in the Killary Approaches where *E. siliqua* is the dominant species in terms of biomass (likely TAC of about 15 tonnes), most beds are dominated by *E. arcuatus*. Total biomass in the surveyed areas are 933 tonnes (*E. arcuatus*), 136 tonnes (*E. siliqua*) and 41 tonnes (*Ensis* spp). Extrapolated or potential biomass including areas of likely distribution beyond the limits of the surveyed areas are 1,509 tonnes (*E. arcuatus*), 264 tonnes (*E. siliqua*) and 53 tonnes (*Ensis* spp.)

The likely annual TACs for *E. arcuatus* range from 1.9 tonnes in Cruit Bay (small bed of about 0.25 km^2) to about 58 tonnes in Clifden Bay and 45 tonnes in Rutland sound. Taking all areas together, including existing fisheries in Clifden and Iniskeas, the likely annual combined TACs are 233 tonnes for *E. arcuatus*, 34 tonnes for *E. siliqua* and 10.3 tonnes for *Ensis* spp.

The sustainability of the TACs options outlined in this report is unknown. Most of these stocks are unexploited and the survey data provides the first estimates of unexploited biomass and size structure. Any fishery development strategy evolving from an unexploited status to maximum sustainable yield (represented by harvest rate of 20-30% as assumed here) makes a number of assumptions about the stocks response to exploitation. In the case of razor clam stocks the response to exploitation and generation of surplus production which could be harvested could include

- Increased recruitment of juveniles due to reduced competition for space and reduced cannibalism of settling larvae by adults. This is a common response in infaunal bivalve species
- Increased growth rate if growth is density dependent
- Reduced growth rate due to gear contact
- Increased 'unobserved' mortality due to contact with fishing gear
- Changes in species composition, diversity and dominance in the habitat which may affect recruitment of *Ensis* spp.

In some beds at least there are indications of missing year classes indicating that recruitment is not annual or that there are episodic mortality events perhaps due to effects of harmful algal blooms. Forecasting sustainable harvest rates in these situations is problematic. Stocks with missing age classes may not support annual fisheries. The most appropriate approach for developing new fisheries and being consistent with existing protocols developed by the Inshore Management Group for new fisheries, is to ensure a monitoring programme exists, that over investment (capitalisation) does not develop and to have prior agreement between industry and authorities of the need to be adaptive in response to monitoring data.

Table 11. Biomass estimates for *Ensis* spp. in each surveyed area. The assessed biomass is based on the survey data applied to the area surveyed. The potential biomass is based on the survey data applied to a larger area (in some cases) where suitable habitat seems available and is contiguous with the surveyed area and given that the surveys did not identify the boundaries of the beds. The lowest expected TAC is based on the lower 95% confidence limit for the assessed biomass and a 20% annual harvest rate. The likely TAC is based on a 25% harvest rate of the average assessed biomass. The maximum TAC is based on a 30% harvest rate of the average potential biomass. The areas (km^2) contained by the surveys and the likely areas of distribution of Razor clams, given available habitat and depth in each area, are indicated.

Species	Location	Assessed biomass (t) ± 95% CI		Potential biomass (t) ± 95% CI		Lowest expected TAC (t)	Likely TAC (t)	Maximum expected TAC (t)	Survey area (km^2)	Distribution area (km^2)
Ensis arcuatus	Gweedore Bay	69.09	± 21.59	140.29	± 43.29	9.5	17.27	55.07	1.21	2.54
	Cruit Bay	7.53	± 4.53	11.68	± 7.07	0.6	1.88	5.63	0.25	0.38
	Rutland Sound	178.07	± 37.00	210.79	± 43.34	28.21	44.52	66.71	3.57	4.55
	Ballinakill Bay	111.36	± 90.38	162.26	± 137.01	4.2	27.84	89.78	0.28	0.36
	Clifden Bay	230.55	± 14.53	365.83	± 21.71	43.2	57.64	116.26	0.45	0.75
	Turbot Island Clifden	63.91	± 6.89	143.86	± 15.82	11.4	15.98	47.9	0.07	0.16
	Inisbofin	72.39	± 39.81	126.4	± 69.18	6.52	18.1	58.67	0.26	0.46
	Killary Approaches	46.95	± 17.74	96.78	± 33.73	5.84	11.74	39.15	0.86	1.34
	Broadhaven Bay N	46.41	± 34.69	46.41	± 34.69	2.34	11.6	24.33	0.355	0.355
	Broadhaven Bay S	30.18	± 12.54	30.18	± 12.54	3.53	7.55	12.82	0.91	0.91
	Iniskeas	76.63	± 14.97	202.71	± 40.57	12.33	19.16	72.98	0.178	0.46
	Sub-total	**933.1**		**1,537.19**		**127.7**	**233.3**	**589.3**		
Ensis siliqua	Gweedore Bay	14.21	± 3.06	35.01	± 7.54	2.23	3.55	12.77		
	Cruit Bay	12.85	± 4.73	20.2	± 7.48	1.62	3.21	8.3		
	Rutland Sound	23.02	± 4.05	34.7	± 6.1	3.79	5.76	30.71		
	Ballinakill Bay	3.06	± 2.35	3.51	± 2.71	0.14	0.77	1.87		
	Inisbofin	0.33	± 0.28	0.8	± 0.45	0.01	0.08	0.38		
	Killary Approaches	60.01	± 13.85	95.32	± 23.24	9.23	15	35.57		
	Broadhaven Bay N	5.32	± 1.55	5.32	± 1.55	0.75	1.33	2.06		
	Broadhaven Bay S	17.18	± 10.64	17.18	± 10.64	1.31	4.3	8.35		
	Sub-total	**136**		**212.04**		**19.1**	**34**	**100**		
Ensis spp.	Adrigole Harbour	2.23	± 1.75	10.9	± 8.64	0.1	0.56	5.86	0.043	0.176
	Bearhaven	39.05	± 16.69	42.11	± 18.15	4.47	9.76	18.08	0.175	0.182
	Inisturk				10			3.3	0.17	0.17
	Sub-total	**41.3**		**53**		**4.6**	**10.3**	**23.9**		
Totals		**1,110**		**1,826**		**151**	**278**	**713**	**8.781**	**12.793**

5 Cockle (*Cerastoderma edule*)

5.1 Management advice

Dundalk Bay is managed under a Natura 2000 site fisheries management plan. The Dundalk cockle stock is assessed by annual survey and in season LPUE data. Trends in other ecosystem indicators (benthic habitats, bird populations) are integrated into management advice. TAC is 33% of total biomass on condition that ecosystem indicators for designated habitats and bird populations are stable.

Maintenance of good environmental status in the intertidal habitats in which these fisheries occur is a primary management objective in order to reduce the risk of future recruitment failure and to ensure that conservation objectives for designated habitats and species are protected. Any cockle fisheries in SACs or SPAs in other areas should be subject to management plans considering their potential effects on designated habitats and birds.

Pre-fishery summer surveys in Dundalk Bay in 2016 and 2017 showed strong recruitment and good over wintering survival of cockles. Biomass in 2017 was the second highest on record. The harvest control rules which have been in place since 2007 should be continued but the limit reference biomass at which a fishery takes place should be increased from 850 tonnes to 1500 tonnes or at least harvest rates between 850 and 1500 tonnes should be reduced.

5.2 Issues relevant to the assessment of the cockle fishery

There are a number of cockle beds around the Irish coast, however in recent years the main fishery has occurred in Dundalk Bay.

Recruitment of cockles in Dundalk Bay occurs regularly but overwinter survival, in particular, is highly variable. As a consequence biomass, in some years, is insufficient to support a fishery. Recruitment failures occur frequently in the Waterford estuary and overwinter survival is also generally low. In most areas growth rates are lower than in Dundalk and cockles need to survive over 2 winters to reach commercial size compared to 1 winter in Dundalk.

Annual surveys, provided they are completed close to the prospective opening date for the fishery, provide good estimates of biomass available to the fishery and the prospective catch rates. Growth and mortality result in significant changes in biomass over short periods of time.

Dundalk Bay is under a Natura 2000 site management regime and a fishery natura plan for cockles. Cockle is both a characterising species of designated habitats within these sites and also an important food source for overwintering birds. Management of cockle fisheries takes into account the conservation objectives for these habitat and species.

Continuing commercial fisheries for cockles in Natura 2000 sites will depend on favourable conservation status of designated environmental features that may be affected by this fishing activity or a clear demonstration that changes to designated features are not due to cockle fishing.

5.3 Management Units

Cockle stocks occur in intertidal sand and mud habitats. These habitats occur as isolated and discrete areas around the coast and as a consequence cockle stocks occur as locally self-recruiting populations.

Although there are many cockle populations around the coast only Dundalk Bay has supported commercial dredge fisheries in recent years. There is a small scale commercial hand gathering fishery in Castlemaine Harbour (Kerry). Commercial stocks also occur in Tramore Bay and Woodstown Co. Waterford and in Clew Bay Co. Mayo but these stocks have not been commercially fished in recent years. In addition cockle stocks occur in Mayo (other than Clew Bay), Kerry, Sligo and Donegal in particular but these have not been surveyed and are not commercially fished.

5.4 Management measures

The management measures for the Dundalk fishery are described in 5 year management plans (2011-2016 and 2016-2020) and specified in annual legislation in the form of Natura Declarations (www.fishingnet.ie).

In Dundalk Bay a cockle permit is required to fish for cockles either by vessel or by hand gathering. The number of vessel permits is limited to 32. The permit is transferable.

Annual TAC is set at 33% of biomass estimated from a mid-summer survey. The fishery closes if the average catch per boat per day declines to 250 kg even if the TAC is not taken. This provides additional precaution given uncertainty in the survey estimates. Opening and closing dates are specified annually. The latest closing date of November 1st is implemented even if the TAC has not been taken or if the catch rate remains above the limit for closure. Vessels can fish between the hours of 06:00 and 22:00. Maximum landing per vessel per day is 1 tonne. Dredge width should not exceed 0.75 m in the case of suction dredges and 1.0 m for non-suction dredges. The minimum legal landing size is 17 mm but operationally and by agreement of the licence holders the minimum size landed is 22 mm. This is implemented by using 22 mm bar spacing on drum graders on board the vessels.

Environmental performance indicators are reviewed annually as part of the management plans and the prospect of an annual fishery depends on annual evidence that there is no causal link between cockle fishing and in particular the abundance of oyster catcher and other species of bird that feed on bivalves and the status of characterising bivalve species in intertidal habitats.

5.5 Dundalk Bay

5.5.1 Biomass and landings 2007- 2017

Biomass estimates from annual surveys in 2007-2017 are not strictly comparable because of differences in the time of year in which surveys were undertaken (Table 12). The annual estimates are highly sensitive to the timing of in year settlement and seasonal mortality of established cohorts relative to the time in which the surveys are undertaken. The March 2007 survey for instance would not have detected settlement that occurred in 2007. Nevertheless since 2009 surveys have been undertaken either in May or June.

Biomass has varied from a low of 814 tonnes in 2010 to 3,588 tonnes in 2008. Biomass increased annually between 2014 and 2017 from 972 tonnes to 2,316 tonnes. TAC is based on an advisory 33%

exploitation rate provided that the survey biomass is over 850 tonnes. In effect however no fishery has occurred when the biomass was less than 1,032 tonnes (2015). When the fishery is opened the TAC uptake has varied from 15% (2009) to 100% (2017). This depends on distribution of biomass and the commercial viability of fishing and market prices.

Table 12. Annual biomass, TAC and landings of cockles in Dundalk Bay 2007-2017.

Year	Survey Month	Biomass		TAC (tonnes)	Landings	
		Mean	95% CL		Vessels	Hand gatherers
2007	March	2277	172	950	668	Unknown
2008	August	3588	1905	0	0	0
2009	June	2158	721	719	108	0.28
2010	May	814	314	0	0	0
2011	May	1531	94	510	325	0.25
2012	May	1234	87	400	394	9.4
2013	June	1260	99	416	343	0
2014	June	972	188	0	0	0
2015	June	1032	100	0	0	0
2016	July	1878	87	626	410	0
2017	June	2316	95	772	775	0

5.5.2 Surveys in 2016 and 2017

5.5.2.1 Biomass

Pre-fishery surveys were completed in early summer of 2016 and 2017. Biomass in 2016 and 2017 was 1,879 and 2,316 tonnes respectively (Table 13, Table 14, Figure 22). Biomass in 2017 was the second highest in the 11 year time series. Total allowable catches advised were 626 and 772 tonnes in 2016 and 2017 respectively.

Table 13. Density and biomass of cockles in Dundalk Bay in July 2016.

	Density			Biomass	
Density stratum	**Area**	**Mean**	**S.d.**	**Mean**	**95% C.I.**
[0,1]	1.20	0.20	0.27	2.32	0.99
]1,5]	5.96	2.95	1.18	178.11	19.92
]5,10]	8.29	7.74	1.49	530.55	36.86
]10,20]	7.81	14.10	2.56	838.37	51.11
]20,62]	1.98	29.27	9.69	330.11	40.01
Total	25.24	9.90		1,879.45	77.26

Table 14. Density and biomass of cockles in Dundalk Bay in June 2017.

	Density			Biomass	
Density Stratum	Area	Mean	S.d.	Mean	95% C.I.
[0,1]	1.30	0.17	0.25	3.00	1.19
]1,5]	7.63	2.90	1.14	237.29	22.92
]5,10]	11.44	7.40	1.39	802.85	44.33
]10,20]	6.76	14.15	2.86	729.31	47.43
]20,82]	2.13	33.03	11.97	543.62	66.67
Total	29.26	9.33		2,316.07	95.84

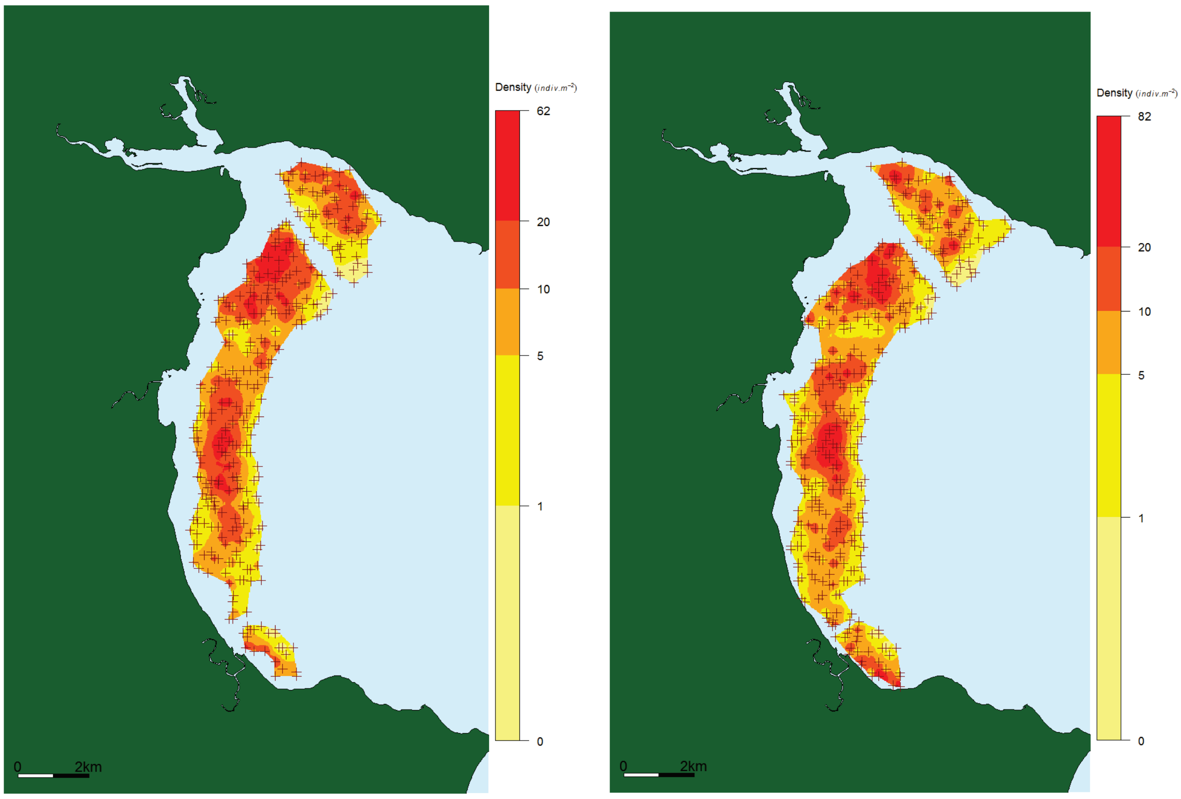


Figure 22. Distribution and density of cockles in Dundalk Bay in June/July 2016 (left) and May 2017. The surveyed area was 25.2 km^2 in 2016 and 29.2 km^2 in 2017.

5.5.2.2 Size distribution and recruitment

Cockles aged 0+ were strongly represented in July 2016 (Figure 23). This cohort (1+ in 2017) accounted for most of the biomass in June 2017 when approximately 50% of the cohort was over the MLS (Figure 24). Cockles aged 0+ were also present in 2017 indicating successful settlement in Spring of 2017.

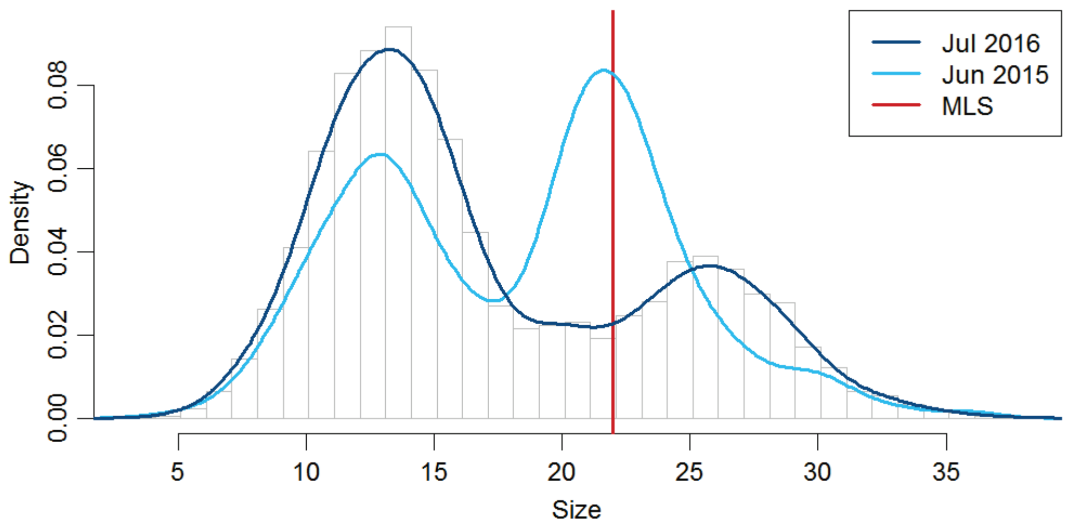


Figure 23. Size distribution of cockles in Dundalk Bay in July 2016 (data for 2015 and the minimum landing size (22 mm) is shown).

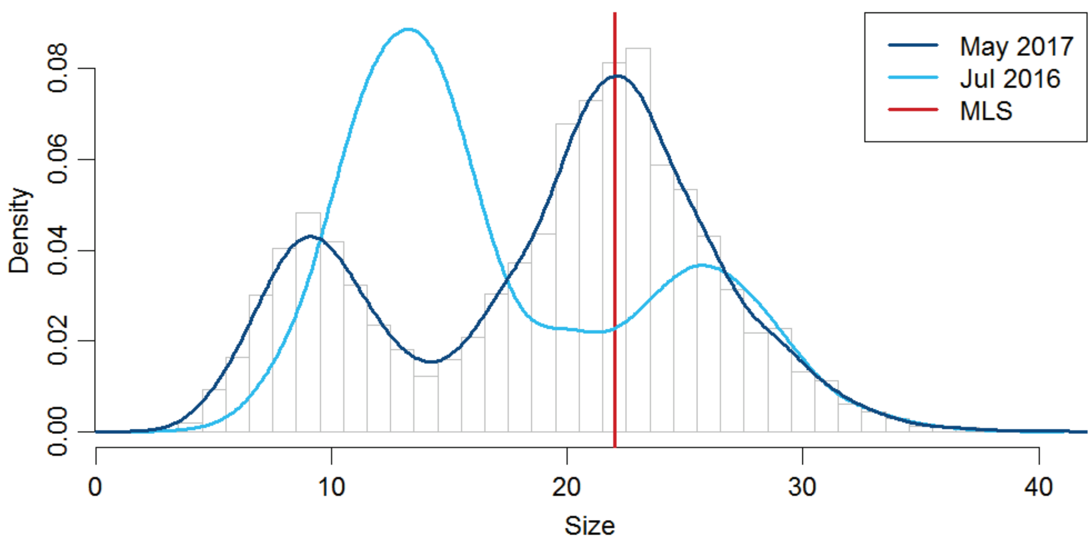


Figure 24. Size distribution of cockles in Dundalk Bay in June 2017 (data for 2016 and the minimum landing Size (22 mm) is shown).

5.5.3 Fisheries in 2016 and 2017

Landings in 2016 and 2017 was 410 and 774 tonnes respectively. Poor take up of the 2016 quota (65%) was due to low market prices. The full quota was taken in 2017.

In 2016 catch rate declined by approximately 25% during the fishery suggesting a pre-exploitation biomass of 1,395 tonnes of cockles over 22 mm compared to a pre-fishery survey estimate of 1,245 tonnes (Figure 25). In 2017 catch rate declined by 40% during the fishery and indicated a pre-fishery biomass of 1,308 tonnes compared to a survey estimate of 1,524 tonnes (Figure 26).

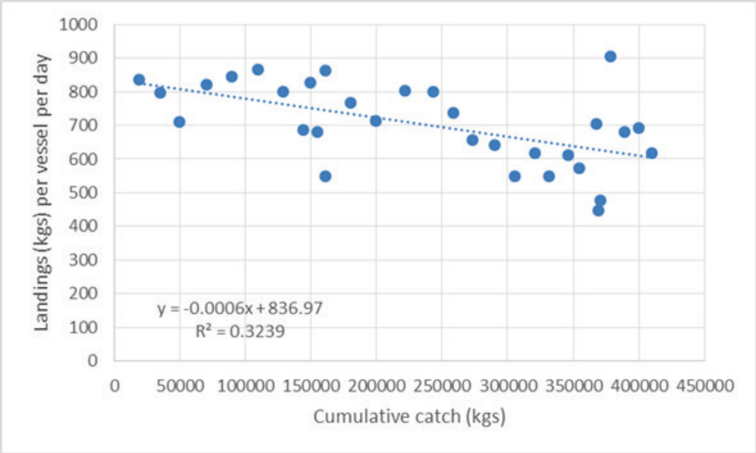


Figure 25. Depletion in catch rate with cumulative landings of cockles in 2016.

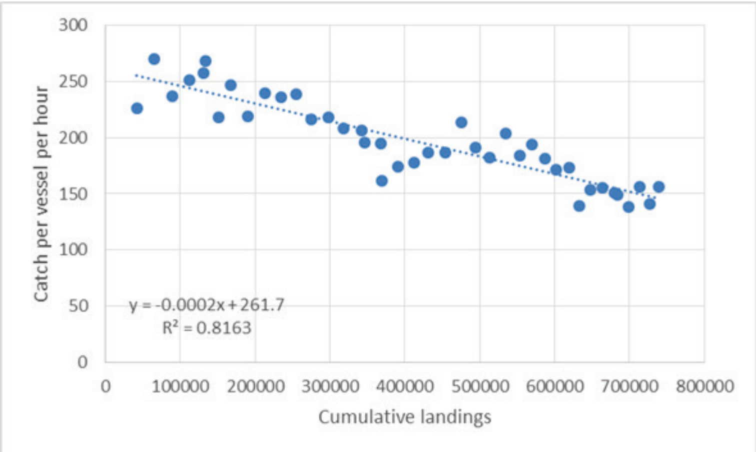


Figure 26. Depletion in catch rate with cumulative landings of cockles in 2017.

6 Oyster (*Ostrea edulis*)

6.1 Management advice

Oyster stocks are assessed by annual surveys which provide biomass estimates although dredge efficiency (catchability) is uncertain.

Stock biomass is generally low in all areas, except Fenit, and management measures to restore recruitment and re-build spawning stocks are necessary. Various threats to native oyster stocks exist including naturalisation of Pacific oyster (*Magallana gigas*), *Bonamia* infection, poor water quality and unfavourable habitat conditions for settlement and low spawning stocks.

Pacific oyster have naturalised in Lough Swilly in recent years and in some years supported a commercial fishery.

Generally, although seasonal quotas and minimum size regulations are in place for some fisheries, management plans or recovery plans should be developed in order to restore productivity to stocks. This should include a range of actions including removal of Pacific oysters, maintenance or recovery of habitat including cultching, closure of fisheries where only a small proportion of oysters are over the minimum size and to allow for growth and use of various aquaculture based stock enhancement measures.

Oyster beds are also constituents of habitats designated under the Habitats Directive in many areas. Specific conservation objectives have been defined for these habitats in some sites. Oyster management plans also need to consider the conservation objectives for oyster habitat or for habitat in which oyster is a characterising species.

6.2 Issues relevant to the assessment of the oyster fishery

A number of native oyster beds occur as separate stocks in Bays around the coast. Biomass is currently low, compared to historic levels, in most areas. The Inner Tralee bed holds the majority of the national biomass of native oyster.

Recruitment is variable in most areas although settlement occurred in all areas recently surveyed. Larval production and settlement is conditional on density of spawning stock, high summer temperatures and the availability of suitable settlement substrate.

The fishery is managed primarily by a minimum landing size (MLS) of 76-78 mm. The minimum size is generally reached at age 4-5. Oysters generally mature well below the MLS.

Oyster stocks face a number of threats including *Bonamia* infection, which decimated stocks in the 1970s, and is prevalent in a number of beds today and in 2017 was detected in the previously *Bonamia* free Kilkieran Bay. Native oyster is also competing for habitat with naturalised Pacific oyster in some areas such as Lough Swilly. Poor substrate conditions for settling oysters may be limiting recruitment and low stock density may also be reducing reproductive output.

Management authority has been devolved to local co-operatives through fishery orders issued in the late 1950s and early 1960s or through 10 year Aquaculture licences. Although conditions, such as maintaining oyster beds in good condition or having management plans in place, attach to these devolved arrangements in most cases management objectives and management measures are not sufficiently developed. In Lough Swilly and the public bed in inner Galway Bay all management authority rests with the overseeing government department rather than with local co-operatives.

Although management may be devolved through the fishery orders or aquaculture licences vessels fishing for oysters must be registered on the sea fishing vessel register (DAFM) and operators must also hold a dredge licence which is issued by Inland Fisheries Ireland (IFI).

The oyster co-operatives operate seasonal fisheries and may also limit the total catch. The TACs may be arbitrary and scientific advice or survey biomass estimates or other indicators have not generally been used in setting TACs.

All the main oyster beds in Ireland occur within Natura 2000 sites. Oyster is a characterising species of sedimentary habitats of large shallow inlets and bays. It can also be a key habitat forming species in conditions where recruitment rates are high and where physical disturbance is low. Seagrass and maerl or other sensitive reef communities are commonly found on oyster beds in Kilkieran Bay, Tralee Bay, Clew Bay (outer). Dredging may damage these communities. Management of oyster fisheries needs to consider the conservation objectives for this species and its associated habitats and communities.

Annual surveys provide biomass indices or absolute biomass estimates and size structure of oyster stocks annually. Poor information on growth rate, which varies across stocks, limits the assessment of mortality rates and yield predictions.

These issues were discussed at the Native Oyster Workshop in October 2017 hosted by Cuan Beo in Clarinbridge (www.cuanbeo.com).

6.3 Management Units

Oyster stocks occur as discrete isolated units in a number of Bays around the coast. Although native oysters were historically widespread in many areas, including offshore sand banks in the Irish Sea and along the south east coast their distribution is now reduced. The main stocks occur in Tralee Bay, Galway Bay, Kilkieran Bay in Connemara, Clew Bay, Blacksod Bay and Lough Swilly.

6.4 Survey methods

Oyster beds are surveyed annually by dredge. Dredge designs vary locally and those locally preferred dredges are used in the surveys. Dredge efficiencies were estimated in 2010 by comparison of the numbers of oysters caught in the dredge and the numbers subsequently counted on the same dredge track by divers immediately after the dredge tow had been completed.

Surveys are undertaken along predetermined grids where the distribution of the oyster beds is well known. In other cases the local knowledge of the Skipper of the survey vessel is used to locate the beds which, in some areas, are patchy and occur at discrete depths on particular substrates. GPS units with visual display of the local area were used to distribute sampling effort throughout the oyster beds, the boundaries of which were indicated by the skipper of the vessel.

Densities, either converted for dredge efficiency or in raw form, were interpolated using an Inverse Distance Weighting (IDW) algorithm. Contours were drawn at intervals reflecting the range in observed densities. The geographic area inside each contour was calculated and used to raise the average densities and biomass of oysters m^{-2} within each contour to the total population or at least that proportion of the population selected by the dredge.

6.5 Inner Tralee Bay

6.5.1 Surveys in 2016 and 2017

6.5.1.1 Biomass Inner Tralee Bay in 2016

A pre fishery survey was completed on September 13^{th} and 14^{th} 2016. A total of 62 tows (average length 77±16 m) were taken on a pre-determined survey grid. The total area surveyed was 3.66 km^2 (Figure 27).

The total biomass of oysters in the survey area, corrected for 35% dredge efficiency, was estimated to be 906±192 tonnes. The biomass of commercial sized oyster was 170±21 tonnes (Table 15, Table 16).

Table 15. Distribution of oyster biomass, corrected for a dredge efficiency of 35%, in Inner Tralee Bay in September 2016.

Biomass stratum	Area (km^2)	Density (oysters m^{-2})		Biomass	
		Mean	S.d.	Mean	95% C.l.
[0,0.19]	0.03	0.03	0.05	0.09	0.08
]0.19,1.18]	1.07	0.51	0.30	36.55	10.89
]1.18,6.1]	1.66	3.07	1.79	277.27	77.46
]6.1,29.2]	0.90	14.25	8.06	592.64	176.43
Total	3.66	5.03		906.54	192.99

Table 16. Distribution of oyster biomass over 78 mm, corrected for a dredge efficiency of 35%, in Inner Tralee Bay in September 2016.

Biomass stratum	Area (km^2)	Density (oysters m^{-2})		Biomass	
		Mean	S.d.	Mean	95% C.l.
[0,0.073]	0.15	0.01	0.02	0.23	0.25
]0.073,0.227]	1.38	0.12	0.04	23.30	4.57
]0.227,0.496]	1.37	0.34	0.08	55.77	7.19
]0.496,1.93]	0.76	1.03	0.44	91.10	19.99
Total	3.66	0.39		170.39	21.73

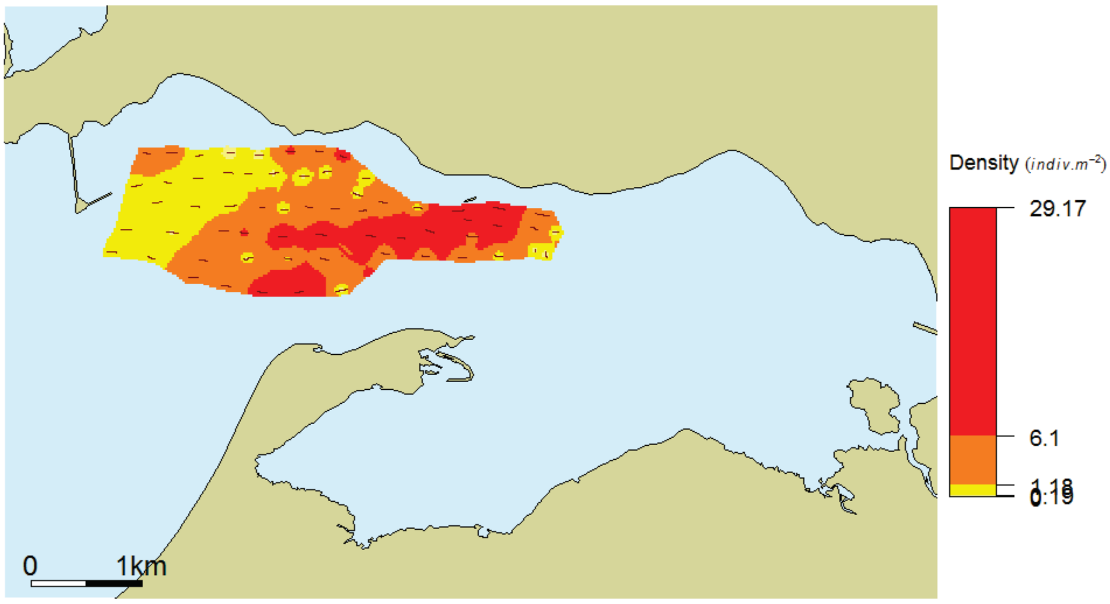


Figure 27. Density and distribution of native oyster in Inner Tralee Bay, September 2016.

6.5.1.2 Biomass Inner Tralee Bay in 2017

A pre fishery survey was carried out on September 19 and 20th. A total of 78 tows were undertaken, with a single toothless dredge of width 1.20 m. The survey encompassed an area of 4.28 km^2 (Figure 28). Biomass, corrected for a dredge efficiency of 35% was 843±151 tonnes. Biomass of commercial sized oysters was estimated to be 193±30 tonnes (Table 17, Table 18).

Table 17. Distribution of oyster biomass, corrected for a dredge efficiency of 35%, in Inner Tralee Bay in September 2017.

Biomass stratum	Area (km^2)	Density (oysters m^{-2})		Biomass	
		Mean	S.d.	Mean	95% C.I.
[0,0.21]	0.04	0.08	0.07	0.20	0.10
]0.21,1.11]	1.01	0.53	0.28	35.02	9.04
]1.11,3.75]	2.10	2.28	0.82	276.06	44.68
]3.75,25.3]	1.13	9.18	6.44	496.88	157.15
Total	4.28	3.67		808.17	163.63

Table 18. Distribution of oyster biomass over 78 mm, corrected for a dredge efficiency of 35%, in Inner Tralee Bay in September 2017.

Biomass stratum	Area (km^2)	Density (oysters m^{-2})		Biomass	
		Mean	S.d.	Mean	95% C.I.
[0,0.035]	0.08	0.01	0.01	0.10	0.09
]0.035,0.176]	1.10	0.09	0.05	13.18	3.40
]0.176,0.389]	2.40	0.28	0.06	87.11	9.48
]0.389,2.02]	0.70	0.74	0.46	67.18	18.97
Total	4.28	0.30		167.57	21.48

Figure 28. Density and distribution of native oyster in Inner Tralee Bay September 2017.

6.5.1.3 Size distribution 2016 and 2017

Oysters ranged in size from 4-111 mm and averaged±sd 54.68±20.44 mm in shell length (Figure 29). Approximately 11.6% of oysters were equal to or over the minimum landing size of 78 mm shell height and a further 10% of oysters were between 73-78 mm. The percentage of oysters over the MLS was lower than in 2015 (12.2%) and 2014 (15.1%), but slightly higher than in 2013 (11%).

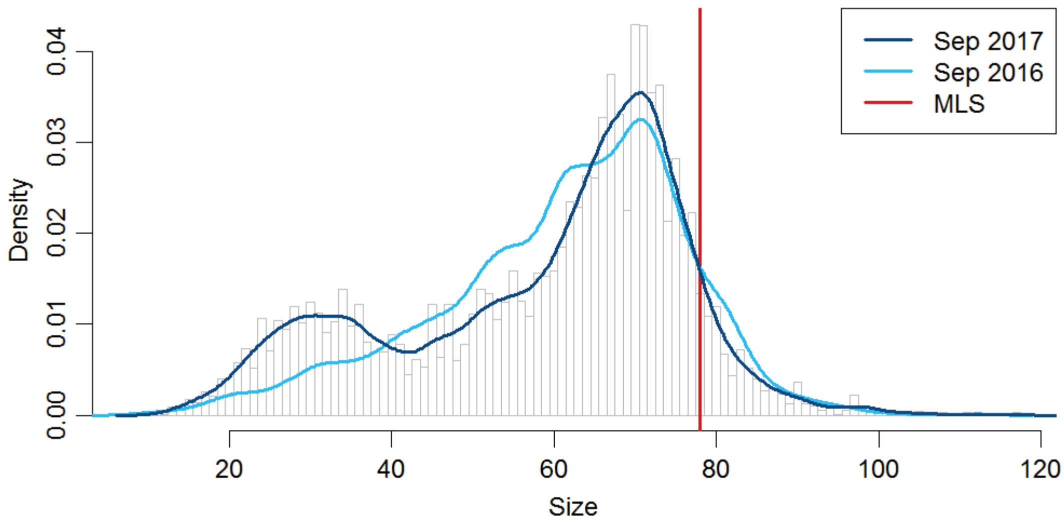


Figure 29. Size distribution of native oysters in the Fenit oyster bed in Sept 2016 and 2017. The MLS (78 mm) is also shown.

6.6 *Lough Swilly*

6.6.1 Surveys in 2016 and 2017

6.6.1.1 Biomass of native oyster 2016

Using a dredge efficiency of 35.5% the estimated biomass of native oyster in September 2016 was 97.09±11.03 tonnes (Figure 30, Table 19). The modal size was 58 mm (Figure 32).

Table 19. Density and biomass of native oysters in Lough Swilly in September 2016 based on a dredge efficiency of 35.5%.

Biomass stratum	Area (km^2)	Density		Biomass	
		Mean (m^2)	S.d.	Total	95% CL Biomass
0	0.01	0.00	0.00	0.00	0.00
0.0149 - 0.099	0.15	0.05	0.01	0.30	0.07
0.1 - 0.49	2.66	0.27	0.03	21.41	2.60
0.5 - 0.99	1.86	0.70	0.05	36.77	2.80
1.0 - 2.49	0.84	1.44	0.20	32.90	4.63
2.5 - 4.82	0.06	3.38	0.55	5.71	0.94
	5.58			97.09	11.03

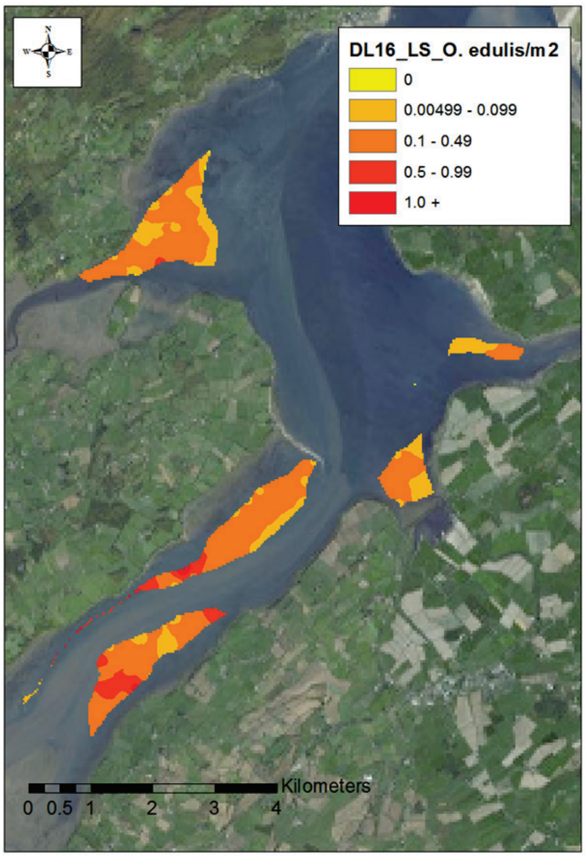


Figure 30. Distribution and density of native oysters (*Ostrea edulis*) in Lough Swilly in September 2016.

6.6.1.2 Biomass of native oyster 2017

Using a dredge efficiency of 35.5% the estimated biomass was 316±28 tonnes and the total number of oysters was estimated to be of 3.5 million. The abundance and biomass of commercial sized native oysters was 0.73 million and 87 tonnes respectively (Table 20, Table 21, Figure 31).

Table 20. Density and biomass of native oysters in Lough Swilly in September 2017 based on a dredge efficiency of 35.5%.

Biomass stratum	Area (km^2)	Density		Biomass	
		Mean	S.d.	Mean	95% C.I.
[0,0.3]	1.1328	0.14	0.10	8.57	2.20
]0.3,1.21]	3.6616	0.68	0.27	114.38	15.53
]1.21,4.18]	2.4012	2.17	0.84	193.35	23.49
Total	7.1956	1.09		316.29	28.24

Table 21. Density and biomass of commercial sized native oysters in Lough Swilly in September 2017 based on a dredge efficiency of 35.5%.

Biomass stratum	Area (km^2)	Density		Biomass	
		Mean	S.d.	Mean	95% C.I.
[0,0.041]	1.5192	0.00	0.01	1.18	1.21
]0.041,0.097]	2.932	0.07	0.02	24.08	2.59
]0.097,0.578]	2.7444	0.21	0.11	62.11	9.83
Total	7.1956	0.11		87.37	10.24

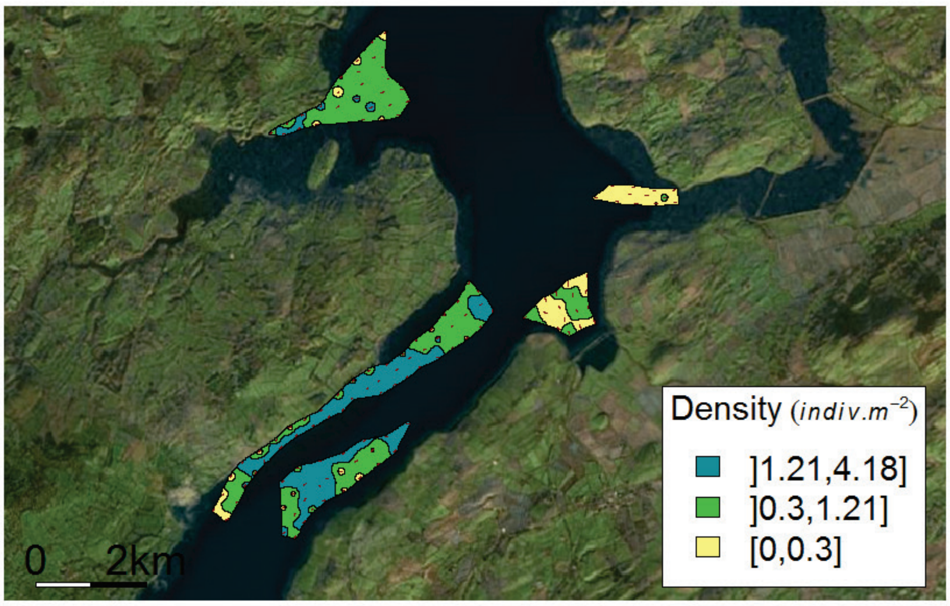


Figure 31. Distribution and density of native oysters in Lough Swilly in September 2017 assuming a dredge efficiency of 35.5%.

6.6.1.3 Size distributions

The modal shell size of *Ostrea edulis* was 58mm in 2016 and 68mm in 2017. Oysters less than 40 mm were more strongly represented in 2017 and the proportion of oysters over the legal size was higher in 2017 (Figure 32). Only 2% of oysters were over the legal size in 2016 compared to 8% in 2017.

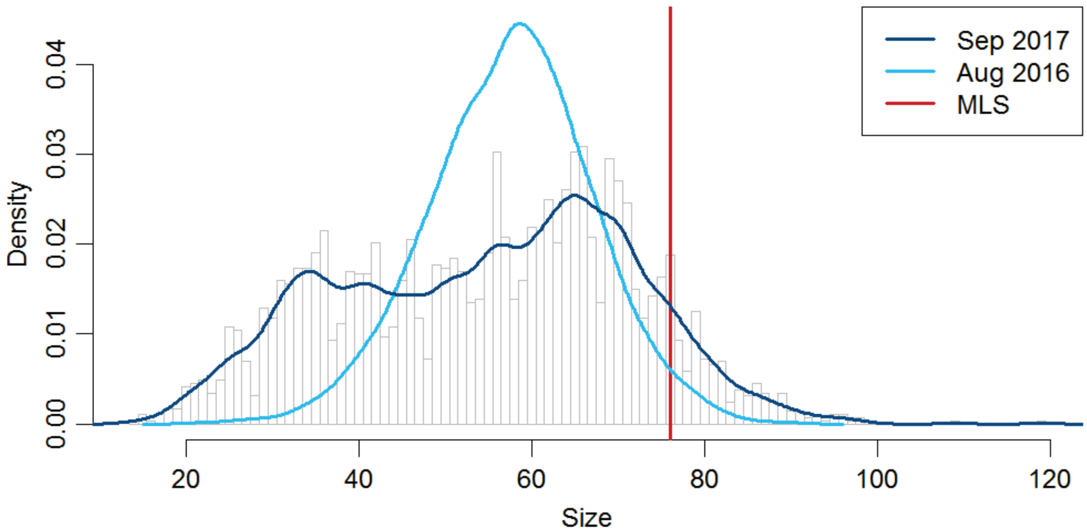


Figure 32. Size distribution of native oysters in Lough Swilly in 2016 and 2017.

6.6.1.4 Distribution and biomass of Pacific oyster (*Magallana gigas*) 2017

Naturalised pacific oysters occurred throughout the survey area in 2017. The estimated biomass was 453±76 tonnes (Figure 33, Table 22). The size distribution was bi-modal with a clear cohort, probably from a settlement in summer 2016, and a larger mode which may include a number of age classes (Figure 34). The 2016 data suggests that there was no settlement of pacific oysters in 2015.

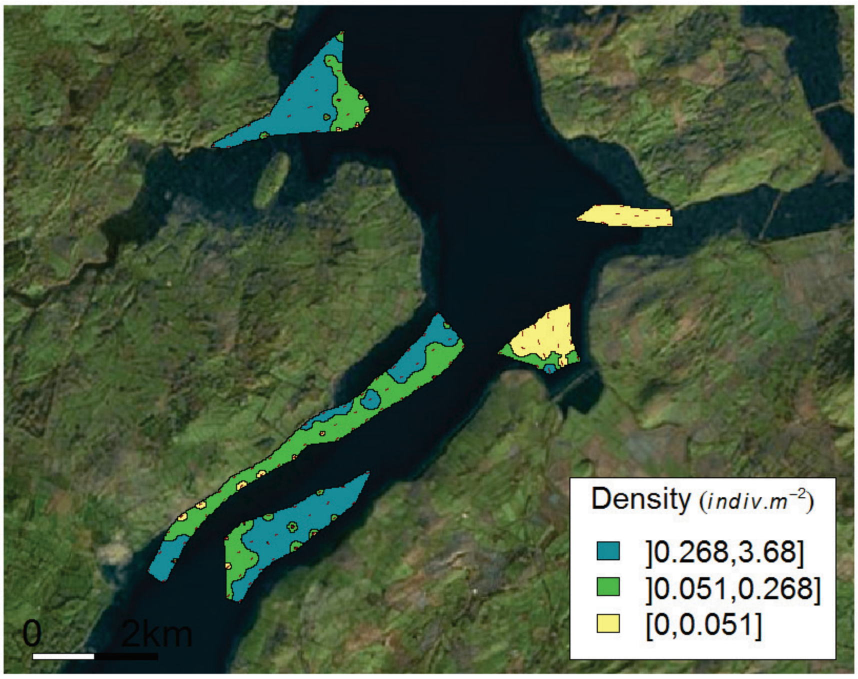


Figure 33. Distribution of Pacific oysters in Lough Swilly in 2017.

Table 22. Biomass of Pacific oysters in Lough Swilly in 2017 based on a dredge efficiency of 35.5%.

Biomass stratum	Area (km^2)	Density (m^{-2})		Biomass	
		Mean	S.d.	Mean	95% c.l
[0,0.0089]	1.07	0.01	0.02	2.91	0.98
]0.0089,0.0492]	3.25	0.14	0.06	84.29	10.90
]0.0492,0.435]	2.87	0.90	0.84	366.47	75.69
Total	7.20	0.48		453.68	76.47

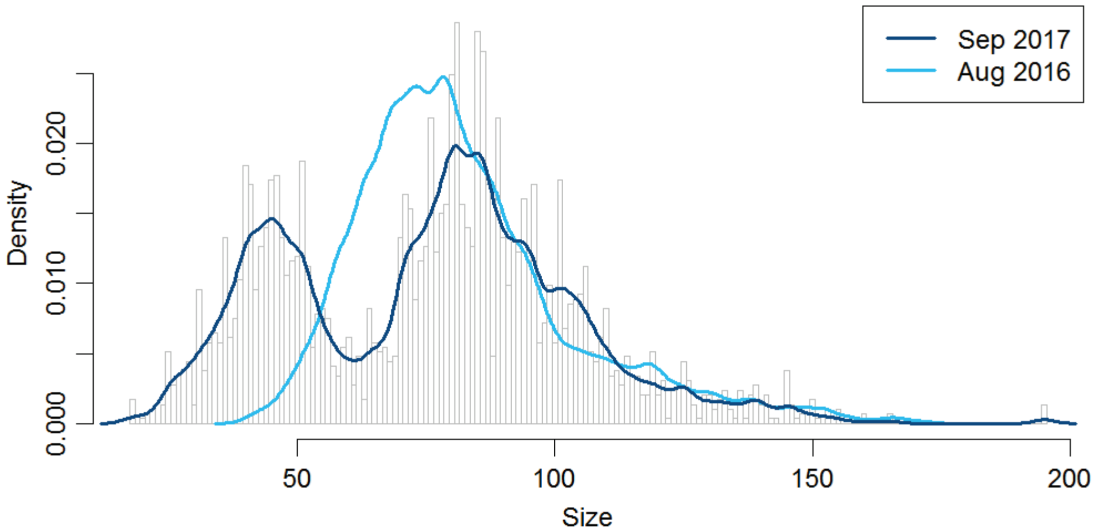


Figure 34. Size distribution of Pacific oysters in Lough Swilly in 2016 and 2017.

6.6.1.5 The ratio of native oyster to pacific oyster

The relative distribution of native and pacific oysters from the 2017 survey shows some areas are dominated by native oysters and in some areas the biomass of Pacific oysters is higher (Figure 35).

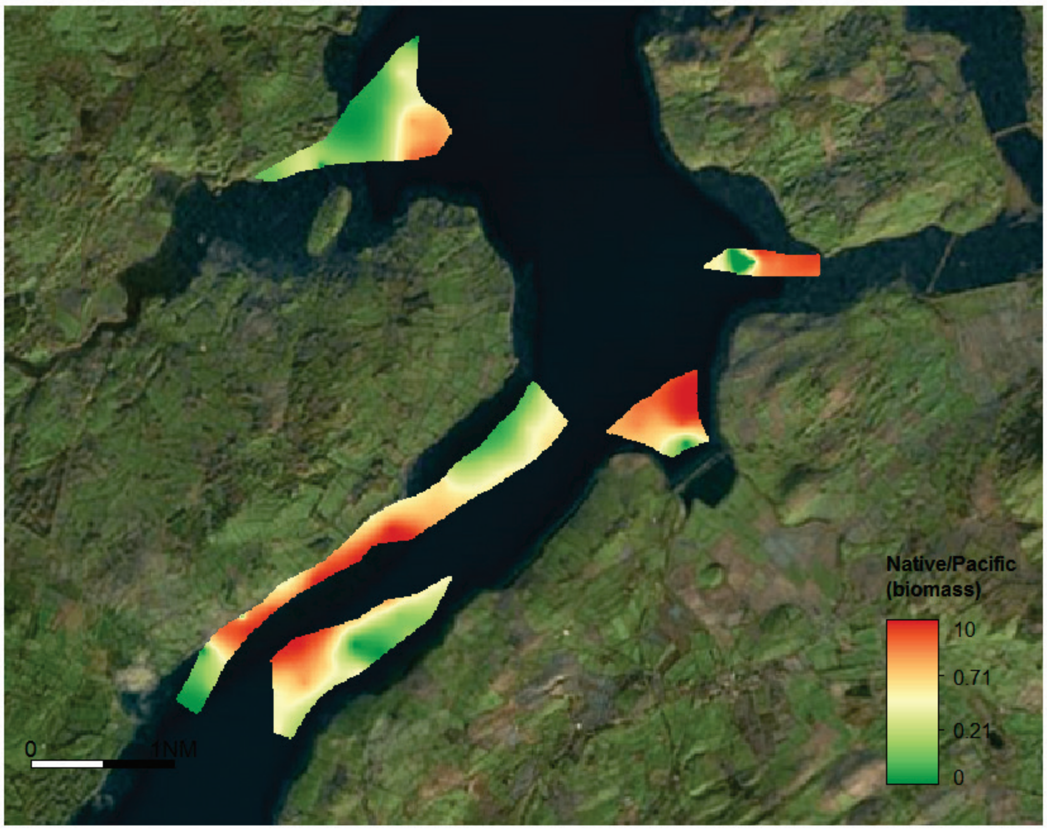


Figure 35. Distribution of the ratio of biomass of native and pacific oysters in Lough Swilly in September 2017. Red areas (higher ratio values) are areas where native oysters are dominant.

6.7 *Galway Bay*

6.7.1 Survey November 2017

The survey area was limited to the area north east of Eddy Island where the fishery usually takes place. Twenty five tows of approximately 50 m length were taken on a 200 m grid using a toothed dredge 1.2 m wide with 18 teeth 60 mm apart and 38 mm deep.

6.7.1.1 Biomass

A total of 2,098 oysters were measured ranging in size from 6 mm to 87 mm. Total biomass, assuming a dredge efficiency of 35%, was estimated to be 111 tonnes within the 0.71 km^2 survey area (Figure 36, Table 23). However, only an estimated 12.6 tonnes was over 76 mm (Table 24).

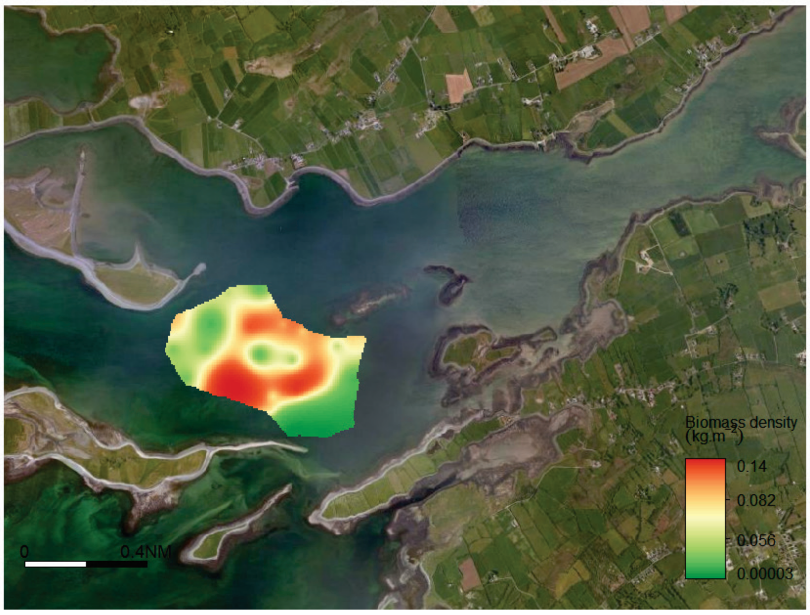


Figure 36. Distribution and biomass of native oyster seaward of the Clarin River estuary in south east Galway Bay in November 2017.

Table 23. Biomass of native oyster in inner Galway Bay in November 2017 based on a dredge efficiency of 35%.

Biomass Stratum	Area (km^2)	Biomass (tonnes)		
		Mean	95% C.I. lower	95% C.I. upper
[0,0.11]	0.10	3.28	0.02	17.66
]0.11,0.22]	0.49	75.95	60.71	92.13
]0.22,0.38]	0.11	31.21	26.15	36.49
Total	0.71	111.09	91.37	134.49

Table 24. Biomass of commercial sized (≥ 76 mm) native oyster in inner Galway Bay in November 2017 based on a dredge efficiency of 35%.

Biomass Stratum	Area (km^2)	Biomass (tonnes)		
		Mean	95% C.I. lower	95% C.I. upper
[0,0.001]	0.02	0.00	0.00	0.00
]0.001,0.015]	0.40	3.53	2.05	5.36
]0.015,0.059]	0.29	9.04	5.99	12.65
Total	0.71	12.64	9.20	16.75

6.7.1.2 Size distribution

Approximately 9% of oysters were over the ring size of 76 mm compared to 20% in March 2016 (last survey) (Figure 37).

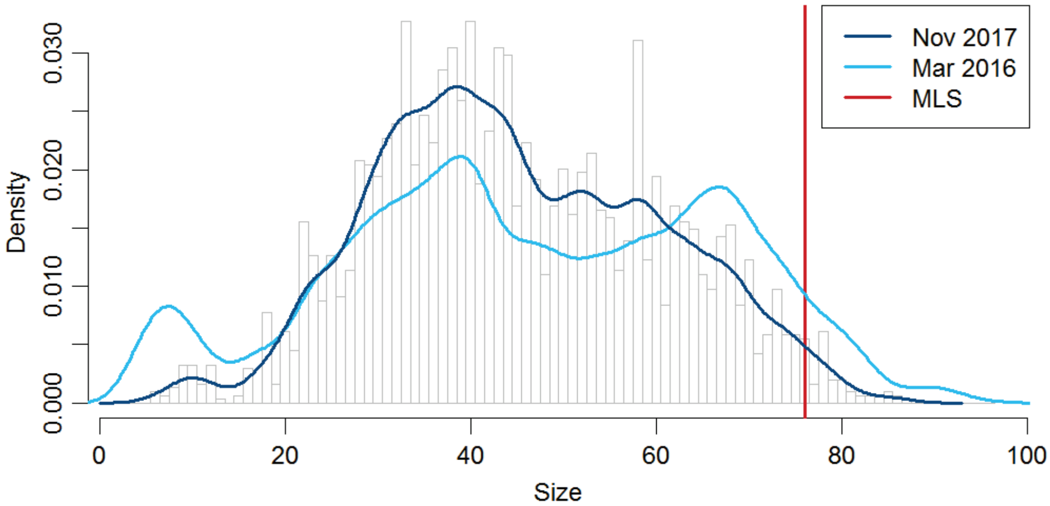


Figure 37. Size distribution of native oysters (*Ostrea edulis*) in south east Galway Bay in November 2017. The minimum landing size (76 mm) is shown.

7 Scallop (*Pecten maximus*)

7.1 Management advice

Offshore scallop stocks are fished by Irish, UK and French fleets. There is no international assessment. Spatially referenced catch rate indicators have been developed for the Irish fleet in the Celtic Sea, Irish Sea and English Channel. Some inshore stocks are assessed by survey which provides biomass estimates under certain assumptions regarding catchability.

Effort distribution across stocks varies annually. From 2006-2012 catch rates increased in all stocks but declined in the period 2013-2016 in the Celtic Sea and Irish Sea. Catch rates in the eastern Channel are much higher but reliant on a single year class and therefore prone to fluctuation.

Fishing effort / landings should be managed at the stock level in proportion to changes in spatially referenced catch rate indicators using data for all fleets until more comprehensive assessments are developed.

Inshore scallop fisheries can have significant negative effects on marine habitats such as geogenic and biogenic reef. Spatial management of scallop fishing should be used to protect such habitats. Offshore scallop fisheries occur mainly on less sensitive sedimentary habitats.

7.2 Issues relevant to the assessment of scallop

No analytical assessments are currently undertaken. Limited size and age data are available from opportunistic sampling of landings from Irish vessels and a series of annual surveys undertaken in the period 2000-2005 in the Celtic Sea. Spatial variability in growth rates in particular indicates the need for a spatially explicit approach to assessment and therefore the need for spatially explicit and systematic sampling programmes.

A number of other approaches to assessment have been explored including depletion assessment of commercial catch and effort data with variable success. The main uncertainty in survey estimates is catchability which varies according to ground type.

7.3 Management Units

Offshore scallop in the Irish Sea, Celtic Sea and western and eastern Channel are spatially discrete stocks (Figure 38) following settlement but are variously interconnected during larval dispersal. Larval dispersal simulations show strong connectivity between the south Irish Sea and north east Celtic Sea, limited east west connectivity across the south Irish Sea between stocks off the Irish coast and Cardigan Bay in Wales and general separation of stocks in the eastern Irish Sea and Isle of Man from stocks further south.

Inshore stocks are small and limited in distribution within Bays on the south west and west coasts and are regarded as separate populations.

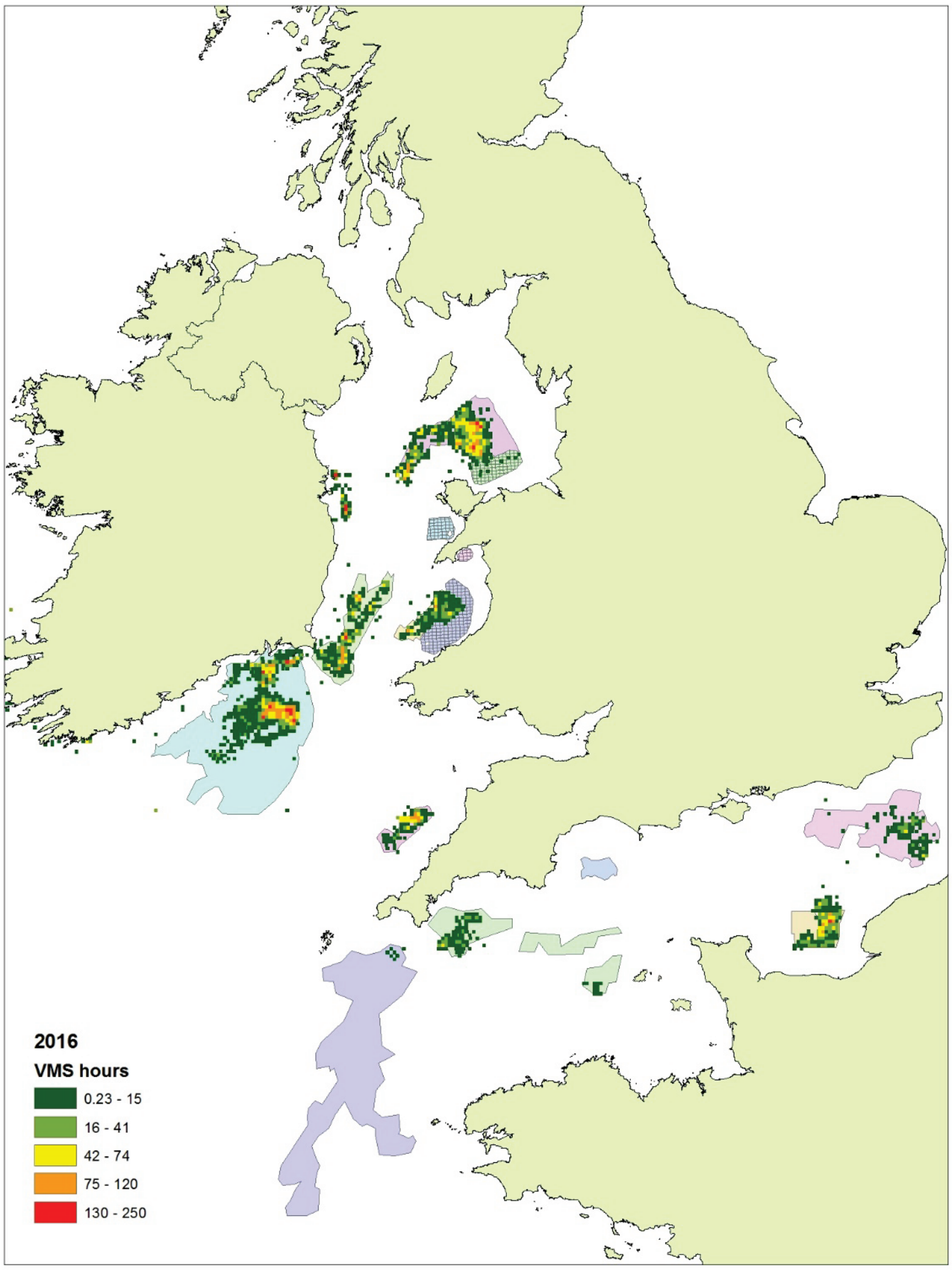


Figure 38. Offshore scallop grounds in the Irish Sea, Celtic Sea and English Channel. Boundaries are defined from the distribution of fishing activity by the Irish fleet 2000-2015 as shown by VMS data and some UK VMS data. The stock boundary limits are likely to be larger especially in the Irish Sea and English Channel considering that the UK and French fleets fish mainly in these areas. VMS data for 2016 (raster 3 km^2 grid) are shown relative to distributional extent of the stocks.

7.4 Management measures

The capacity of the scallop fleet over 10m in length has been limited (ring fenced) since 2006 and an authorisation is required to fish for scallop. The total annual effort (Kwdays) of the fleet is also capped by the Western Waters agreement (EC 1415/2004). Given the relationship between vessel length and dredge number the number of dredges in the fleet can be predicted annually from the length of the vessels authorised (Figure 39). In 2017 the number of dredges on vessels over 10 m was estimated to be approximately 192 compared to an estimated 518 dredges prior to decommissioning of part of the fleet in 2006. Vessels under 10 m in length are unrestricted.

The minimum landing size is 100 mm shell width for most of the offshore stocks other than those in the south Irish Sea where the size is 110 mm. The minimum size for inshore stocks is generally 100 mm although sizes of up to 120 mm are used locally by agreement or as conditions established by shellfish co-operatives that may have aquaculture licences or fishery orders to manage scallop stocks locally eg. Kilkieran Bay.

Scallop fishing is excluded from areas supporting sensitive habitats. These include seagrass and maerl communities in Roaringwater Bay and reef communities in Blacksod Bay, south of Saltee Islands and south of Hook Head SACs.

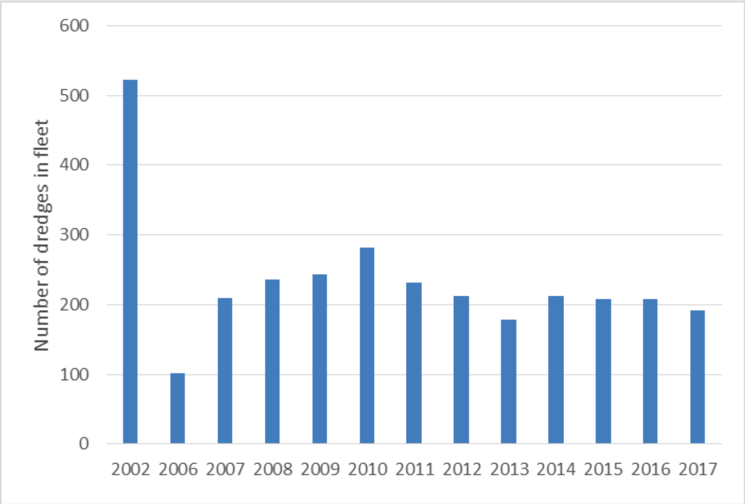


Figure 39. Annual estimated number of dredges in the authorised fleet of scallop vessels over 10 m 2002 and 2006-2017 based on the relationship between vessel length and number of dredges (Dredges = 0.88* Boat length). The fleet was partly decommissioned in 2006.

7.5 Offshore scallop fisheries

7.5.1 Landings

Landings increased from 1995-2004 due to fleet expansion and expansion of the geographic area fished off the south east coast. The fleet was decommissioned in 2006 and restricted in capacity thereafter and landings consequently declined. New vessels entered the fleet after 2006 and landings continued to increase to over 3,000 tonnes in 2013. Landings however declined year on year in 2014 and 2015 (Figure 40).

The Irish fleet fishes in the Irish Sea, Celtic Sea and English Channel. The majority of landings are from the Celtic Sea stock. Fishing in the English Channel is episodic; in recent years the fleet has fished in the eastern Channel while in the period 2000-2006 the fleet fished in the western Channel (Figure 41).

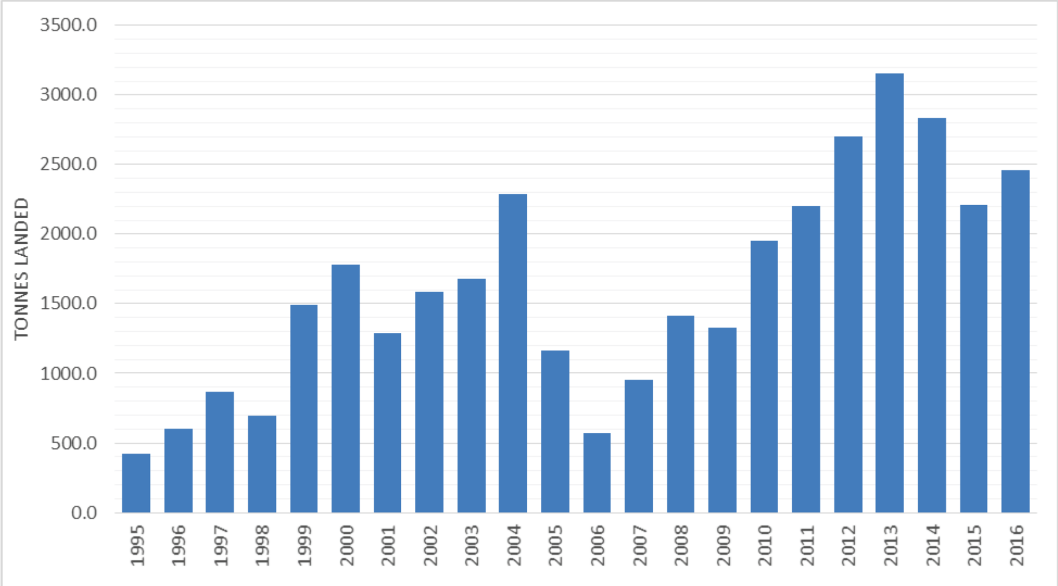


Figure 40. Annual landings of scallop into Ireland 1995-2016.

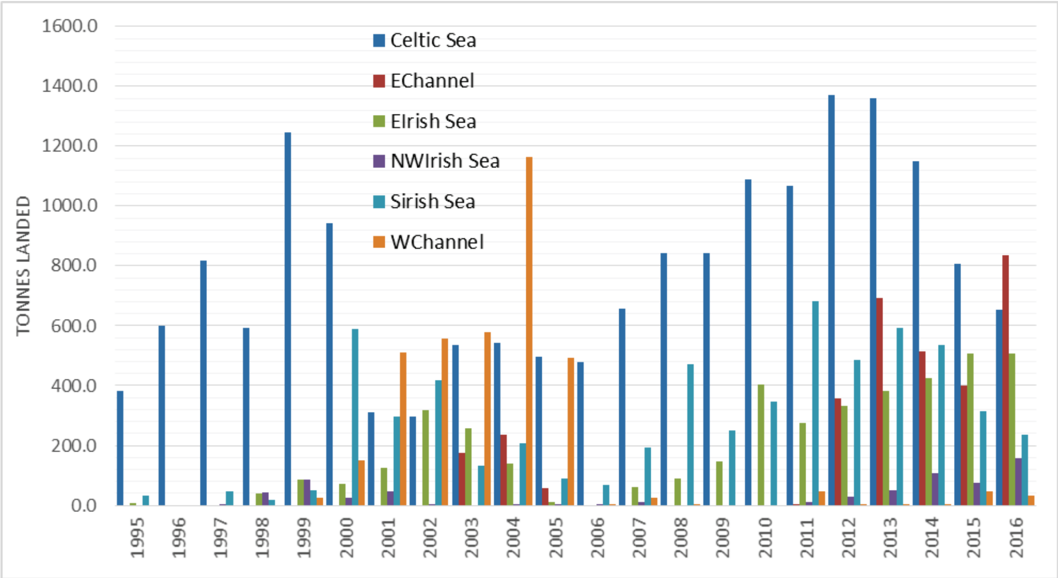


Figure 41. Annual landings by Irish fleet from stocks in the Celtic Sea, Irish Sea and English Channel 2004-2015.

7.5.2 Fishing effort

The majority of fishing effort by the Irish fleet during the period 2005-2016 was in the Celtic Sea (Figure 42). Effort in the Celtic Sea declined between 2012 and 2016. Effort also declined in the south Irish Sea from 2011 to 2016. Effort increased in the east Irish Sea and west Irish Sea. Effort increased in the eastern Channel from 2012 although it was lower in 2015.

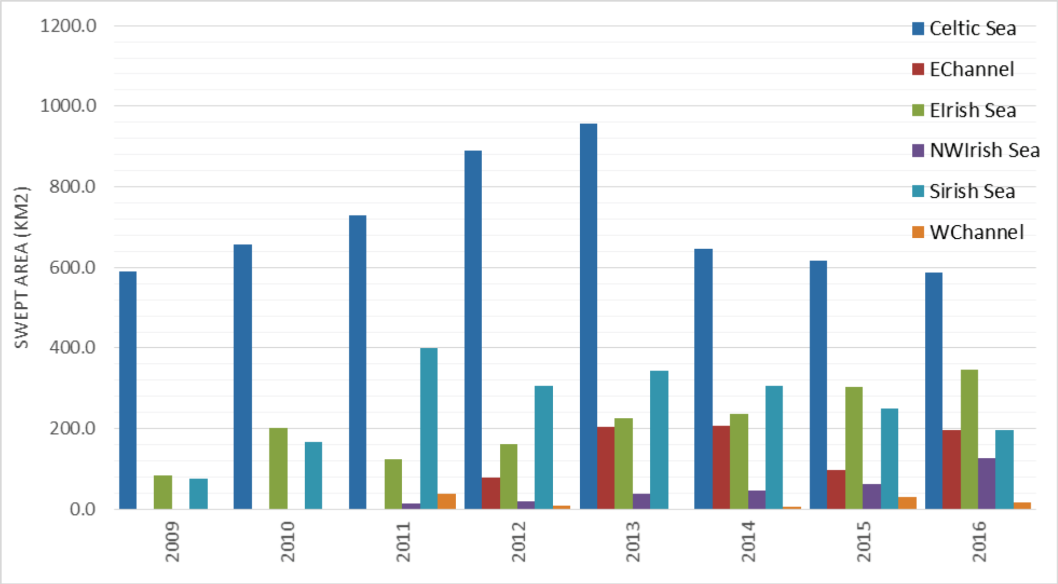


Figure 42. Annual estimated ground area swept by the Irish Scallop fleet 2006-2016

7.5.3 Catch rate indicators

Catch rates kgs.dredge^{-1}.day^{-1} ranged from 30-60 kgs.dredge^{-1}.day^{-1} up to 2006 and increased to 80-100 kgs.dredge^{-1}.day^{-1} by 2012. Catch rates declined from 2012-2016. The exception to these trends is in the Eastern English Channel where catch rates are up to 200 kgs.dredge^{-1}.day^{-1}. The Irish fleet fish in this area in quarter 4 (Figure 43).

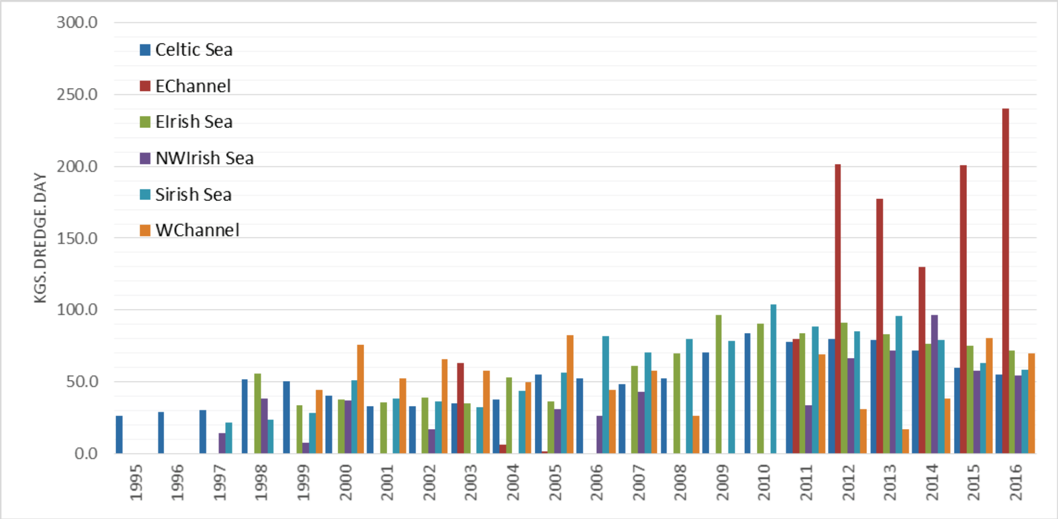


Figure 43. Annual average catch rate (kgs.dredge^{-1}.day^{-1}) of scallop in offshore scallop stocks 1995-2016.

8 Lobster (*Homarus gammarus*)

8.1 Management advice

Lobster stocks are managed using a minimum landing size (MLS) of 87 mm, a maximum landing size (MaxLS) of 127 mm and a prohibition on the landing of v-notched lobsters. Sixty five percent of the reproductive potential (RP) in lobster stocks is in lobsters between 87-127 mm exposed to fishing mortality. An additional 10-13% of RP is in v-notched lobsters between 87-127 mm, 16% of RP is protected by the MLS, 8.3% is above the MaxLS and half of this 8.3% is also v-notched. The MLS, MaxLS therefore protects 24% of current RP and v-notching protects a further 10%. There is a lot of variation in these figures in different coastal areas.

Nominal stock status indicators, catch per unit effort, landings per unit effort and undersized lobsters per unit effort showed stable or positive trends during the period 2001-2016 in most coastal areas suggesting that RP levels are enabling stable or improving recruitment.

Conservation measures should be maintained. The MaxLS is a size refuge for lobsters that have previously been v-notched. Over 50% of lobsters over the MaxLS have previously been notched. V-notching should target lobsters over 95 mm to maximise egg production prior to repair of the v-notch and should be directed to coastal areas where the prevalence of v-notched lobsters is currently low. Specific targets should be set for the proportion of the mature female lobster stock to v-notch and achievement of this figure should be monitored through logbook and observer programmes.

Reliance on the v-notch programme to protect RP should be reduced if there is any uncertainty about continued funding of the programme, if the logistics of implementing it increase or if the voluntary participation in the programme by lobster fishermen declines.

8.2 Issues relevant to the assessment of lobster

Lobsters cannot be aged. Size distribution data varies spatially and raising to the size distribution of the landings is difficult as spatial effects are strong. These data come from observers who work on board lobster vessels between May and October mainly.

Some growth rate data are available for Irish stocks from tag returns. Size at maturity has been estimated a number of times.

Egg per recruit assessments are used to compare the relative merits of different technical conservation measures namely size limits and v-notching. Estimating the current position (fishing mortality rate) on the egg per recruit curves is difficult given that this relies on size distribution data and estimates for growth and natural mortality.

Catch rate indicators are available from the sentinel vessel fishery which covers approximately 8% of the fleet. This coverage is insufficient to provide precise estimates of catch rate given the variability in these data in time and space. A number of indicators can be estimated from the data including a recruitment index and an assessment of the % of v-notched lobsters in the catch.

8.3 Management Units

Lobsters are probably distributed as regional stocks along the Irish coast. In 2006 six management units were proposed. Juvenile and adult lobsters do not move over large areas and the stock structure is determined mainly by larval dispersal.

8.4 Management measures

The lobster fishery is managed using technical measures. The minimum size is 87 mm carapace length. A maximum size limit of 127 mm was introduced in 2015 following an egg per recruit assessment which showed low egg production. It is prohibited to land v-notched lobsters. The v-notching of lobsters is voluntary. There are no effort or catch limits.

8.5 Review of management measures

8.5.1 Contribution of v-notching to spawning potential

8.5.1.1 Releases of v-notched

Over 200,000 lobsters were v-notched and released by BIM and Inshore lobster fishermen on all coasts during the period 2002-2016. The size distributions of released lobsters were remarkably consistent during the period 1995-2016 (Figure 44). This reflects consistency in the size distributions in the landings generally and presumably a consistency in the annual rate of fishing mortality. Approximately 30% of lobsters were below the size at 50% maturity at release. These lobsters would be likely to moult once prior to spawning and would already therefore have partially repaired the v-notch prior to providing any benefit to spawning output.

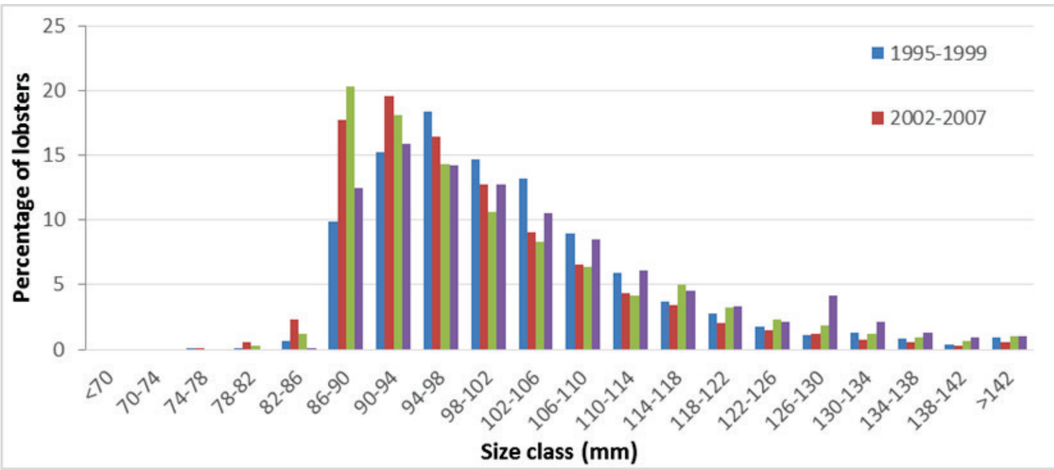


Figure 44. Size distribution of v-notched lobsters released in different time periods since 1995 in Ireland. Data for Kerry 2009-2016 is shown separately as it represents all releases in Kerry compared to samples from releases in other areas.

8.5.1.2 Re-captures of v-notched lobsters

8.5.1.2.1 *Recaptures from Marine Institute observer data*

Recapture of v-notched lobsters are recorded by the Marine Institute Observers at sea programme and also in Sentinel Vessel Programme logbooks by commercial skippers. The percentage of lobsters that are v-notched increases with size (Figure 45) from 3% at the minimum size (87 mm) to over 50% in size classes over the maximum size (127 mm), although there are few lobsters in these size classes. The size distribution of v-notched lobsters is generally similar in all areas. This is not unexpected given that the programme has been in operation in most areas for many years. However the percentage of lobsters that are notched varies. In Clare the percentage of legal lobsters notched increased from 15.6% in 2010 to 21.3% in 2015. In Galway the percentage was 20% in 2015. In other areas the percentages are lower and generally in single digit figures.

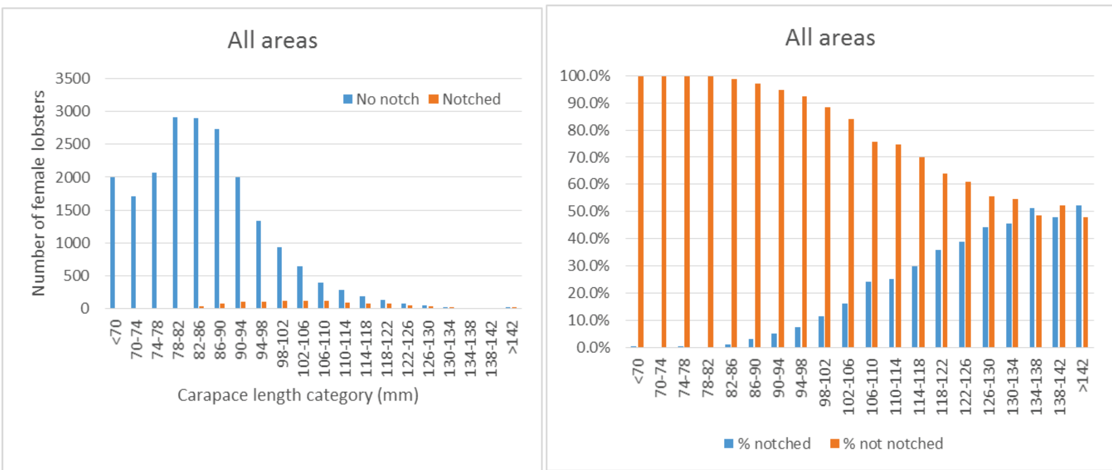


Figure 45. Size distribution (number and percentage) of lobsters in the catch with and without v-notches from 2010-2016 all coastal areas. Source: Marine Institute observer data.

Table 25. Percentage of female lobsters, between 87-127 mm, v-notched by year and area. Source: Marine Institute observer data. 2016 observer data is not available for inclusion.

Area	2010	2011	2012	2013	2014	2015
All	7.1%	8.9%	8.8%	10.8%	10.2%	12.3%
Clare	15.6%	15.3%	19.3%	28.4%	35.3%	21.3%
Cork	6.5%	10.7%	19.5%	1.3%	2.4%	1.7%
Galway	4.0%	7.3%	2.5%	14.5%	11.6%	20.4%
Kerry	3.2%	1.9%	4.0%	5.7%	5.4%	1.9%
Waterford and Wexford	7.3%	7.9%	7.8%	5.5%	22.0%	6.3%
Donegal,Sligo,Mayo	4.5%	6.7%	8.6%	8.2%		29.1%
Louth and Dublin		12.5%		18.8%	4.3%	2.9%

8.5.1.2.2 *Recaptures from SVP data*

The SVP data indicate that the percentage of female legal sized lobsters that are v-notched (assuming 1:1 sex ratio) is generally between 10-20% (Table 26). The data combined for all areas hide a lot of variation geographically. For instance in Clare about 30% of female lobsters are v-notched and this was as high as 57% in 2002-2004. The data refers mainly to south Clare and the Shannon estuary where a small number of vessels have been very proactive in the v-notch programme for over 15 years. In Sligo the percentage of legal sized females notched is 70%. This is for the area between Killala and Enniscrone and the data comes from one vessel who operates an intensive v-notch release programme in the area. In Wexford where the data goes back to 1995 the percentage of legal sized female lobsters increased from 1995 to 1999 to over 30% but subsequently declined to about 20% due to a decrease in the rate of notching. In recent years the percentage is under 10%. The same trend occurred in Waterford. In Kerry the early data from 1996-1999 also showed higher prevalence of v-notched lobsters at 20-50%, similar levels of 25-35% during the period 2002-2006 and lower levels from 2006-2016.

Table 26. Annual average percent of legal sized female lobsters in the catch that have previously been v-notched by County.
The % of v-notch lobsters in the catch has been doubled assuming a 1:1 sex ratio. Data for 2016 incomplete. Data source: SVP data

Year	Clare	Cork	Donegal	Dublin	Galway	Kerry	Louth	Mayo	Sligo	Waterford	Wexford	Wicklow	Average
1995											6.0%		6.0%
1996						22.3%					15.2%		15.6%
1997						30.9%					19.5%		21.6%
1998						50.0%					28.0%		35.1%
1999						44.0%					31.3%		33.3%
2000											18.9%		18.9%
2001											19.5%		19.5%
2002	38.3%	27.8%	2.9%		4.5%	24.7%		13.4%		27.6%	20.5%		22.4%
2003	57.6%	30.7%	1.0%		0.6%	29.7%		10.4%		26.3%	21.2%		26.8%
2004	33.3%	6.2%				26.8%					19.9%		23.4%
2005	26.3%					28.6%		11.0%		41.8%	10.2%		13.0%
2006	3.1%					35.5%		16.1%		38.1%	34.6%		15.1%
2007	34.7%	28.7%			23.6%	18.2%		18.0%					25.2%
2008	28.6%		3.9%		21.6%	13.5%		26.4%		12.3%	32.9%		21.0%
2010	20.9%	20.8%	10.7%	10.0%	9.2%	5.0%	4.3%	26.4%		14.8%	12.0%		14.0%
2011	18.2%	12.5%	17.6%		4.1%	10.2%		18.7%		28.0%	13.9%		13.3%
2012		9.1%	9.3%		40.0%	8.2%				13.8%	1.2%		8.6%
2013	26.7%	17.1%	23.2%	1.5%	24.2%	7.6%		11.2%		15.9%	14.3%		18.7%
2014	24.7%	12.9%	17.7%	2.0%	15.4%	11.6%	13.1%	27.5%		20.8%	9.3%		16.6%
2015	26.7%	12.5%	13.4%	16.0%	6.6%	7.0%	10.3%	14.0%	70.1%	7.8%	7.3%		12.0%
2016		22.3%	16.5%		1.6%	7.1%	9.8%			12.3%	10.3%		12.0%
Average	**27.9%**	**15.3%**	**9.2%**	**11.0%**	**11.5%**	**21.4%**	**7.5%**	**17.8%**	**70.1%**	**22.6%**	**16.7%**		**17.6%**

8.5.1.3 Relative reproductive potential of v-notched lobsters

The reproductive potential for a given size class of lobsters is the product of the number of lobsters in the size class, the probability of maturity, the spawning frequency and the size related fecundity.

8.5.1.3.1 *Marine Institute data*

Overall the data shows that 65% of the RP is in non-v-notched lobsters between 87-127 mm i.e. in legal lobsters (Table 27, Figure 46, Figure 47). About 13% of RP between 87-127 mm is protected in v-notched lobsters. A further 15% is protected by the MLS (practically all of this in non-v-notched lobsters), 6% of reproductive potential is above the 127 mm distributed evenly across v-notched and non v-notched lobsters. Overall therefore the MLS and MaxLS protects 21% of egg production from fishing and v-notching protects a further 13%. County Clare is the exception to this where 46% of total RP is protected in v-notched lobsters between 87-127 mm and a further 17% is protected by the 127 mm (12% of this is v-notched). About 5% of RP is protected by the MLS. In Clare therefore only 32% of the RP is exposed to fishing. Obviously there is some redundancy in the legislation where lobsters over 127 mm that are v-notched or under 87 mm v-notched (very few) are doubly protected. In other areas the % RP protected by v-notching varies from 10-19%.

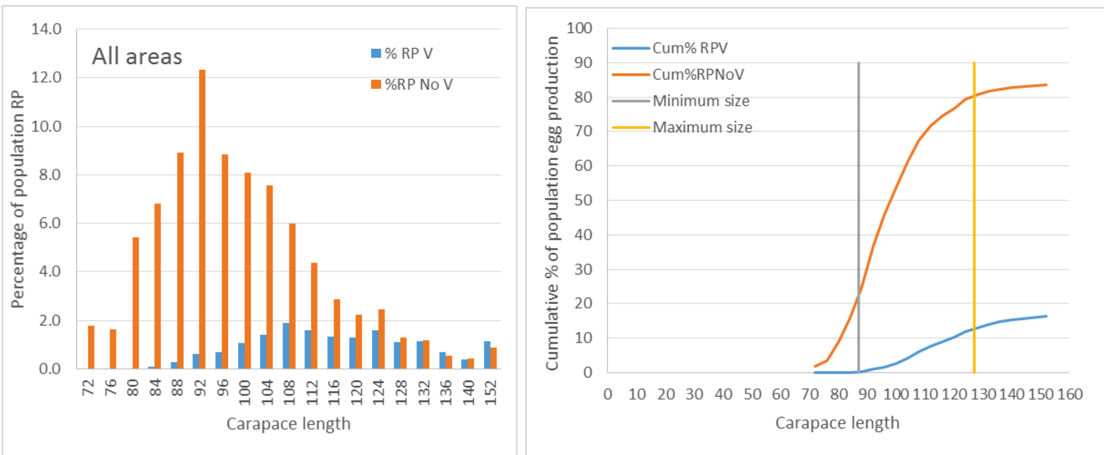


Figure 46. Distribution (left) and cumulative distribution (right) of reproductive potential (RP) across size classes of v-notched and non v-notched lobsters all areas combined.

Table 27. Summary of the distribution of the % reproductive potential across different components of the lobster stock in each area. The % RP notched and not notched shows the contribution of v-notched lobsters compared to non v-notched lobsters. Subsequent columns show the %RP below MLS, above MaxLS and between MLS and MaxLS for v-notched and non-v-notched lobsters. Data: MI observer programme.

	% RP V-notched	% RP No notch	% RP					
			< 87mm V-notched	< 87mm No notch	> 127mm V-notched	> 127mm No notch	87-127mm V-notched	87-127mm No notch
All	16	84	0.12	15.66	3.35	3.03	12.87	64.96
Clare	59	41	0.42	4.78	12.10	4.47	46.44	31.80
Galway	17	83	0.06	13.28	2.46	7.79	14.66	61.75
Donegal, Mayo, Sligo	13	87	0.20	25.09	1.79	4.98	10.96	56.98
Waterford, Wexford	19	81	0.07	15.22	6.87	8.45	11.91	57.48
Cork	16	84	0.03	9.88	2.32	3.94	13.92	69.91
Kerry	10	90	0.00	14.76	2.78	3.05	7.09	72.33
Irish Sea	10	90	0.21	12.48	2.47	6.33	7.26	71.24

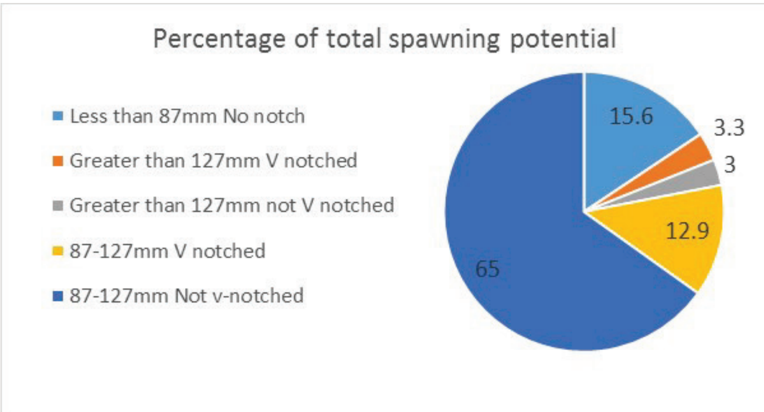


Figure 47. Summary of the distribution of the % reproductive potential in lobster stocks conserved by v-notching, minimum size and maximum size measures.

8.5.1.3.2 *SVP data*

The SVP data, all coastal areas combined, shows that 65% of the RP is in non-v-notched lobsters between 87-127 mm i.e. in legal lobsters. About 10.3% of RP between 87-127 mm is protected in v-notched lobsters. A further 16% is protected by the MLS (practically all of this in non-v-notched lobsters), 8.3% of reproductive potential is above the 127 mm distributed with just over half of this in non v-notched lobsters. Overall therefore the MLS and MaxLS protects 24.3% of egg production from fishing and v-notching protects a further 10.3% (Figure 48, Table 28).

Across different counties the % of RP in v-notched lobsters varies from 7% in the Irish Sea to 23% in Clare.

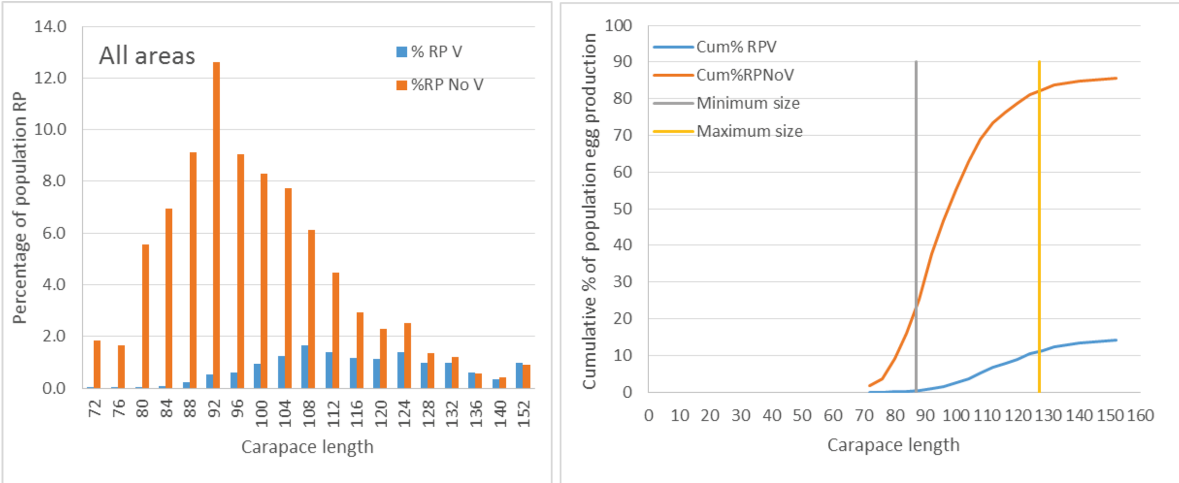


Figure 48. Size distribution and cumulative size distribution of RP in v-notched and non v-notched female lobsters. Data: SVP logbook data for ratio v-notched:non v-notched in the catch applied to the MI Observer size distribution data.

Table 28. Summary of the distribution of the % reproductive potential across different components of the lobster stock in each area. The % RP notched and not notched shows the contribution of v-notched lobsters compared to non v-notched lobsters. Subsequent columns show the %RP below MLS, above MaxLS and between MLS and MaxLS for v-notched and non v-notched lobsters. Data: SVP logbooks.

	% RP V-notched	% RP No notch	% RP < 87mm V-notched	< 87mm No notch	> 127mm V-notched	> 127mm No notch	87-127mm V-notched	87-127mm No notch
All	14	86	0.10	16.00	3.90	4.45	10.30	65.00
Clare	23	77	0.16	8.93	6.27	9.60	16.50	58.50
Galway	12	88	0.04	14.10	1.70	8.26	8.80	64.00
Donegal, Sligo, Mayo	17	83	0.26	23.94	2.90	6.00	14.00	53.16
Waterford, Wexford	12	88	0.04	16.50	5.00	10.40	6.90	61.20
Cork	13	87	0.03	10.27	3.22	5.14	9.95	71.29
Kerry	8	92	0.00	15.00	2.90	4.80	5.00	72.30
Irish Sea	7	93	0.15	12.90	2.03	7.40	4.90	72.69

The differences in the estimated % of RP protected in v-notched lobsters using the MI and SVP data is 2% when all areas are combined (Table 29). The difference in Clare is 36% where the MI data shows much higher % of RP in v-notched lobsters.

Table 29.Comparison of the ratios of v-notched and non-v-notched female lobsters in MI data and SVP data by county 2010-2015 combined.

Area	MI data % V-notched	MI data % No notch	SVP data % V-notched	SVP data % No notch	Absolute difference (%)
All	16	84	14	86	2
Clare	59	41	23	77	36
Galway	17	83	12	88	5
Donegal Mayo Sligo	13	87	17	83	4
Waterford Wexford	19	81	12	88	7
Cork	16	84	13	87	3
Kerry	10	90	8	92	2
Irish Sea	10	90	7	93	3

8.6 Stock status indicators

Catch rate data have been collected from various logbooks, diaries and more recently the SVP programme since 2001. The vessels involved have changed over time and the amount of data and probably the accuracy of the data may also be variable. Data are not currently standardised for seasonal effects or soak times.

The nominal commercial catch rate indicator (lobsters landed per 100 pots hauls) and pre-commercial catch rate indicator (undersized lobsters caught in 100 pots) are both stable or positive over the period 2001-2016. There was some decline during 2007-2012 although the quantity of data available was also lower at this time. This was followed by a recovery to 2007 levels in 2013 (Figure 49, Figure 50).

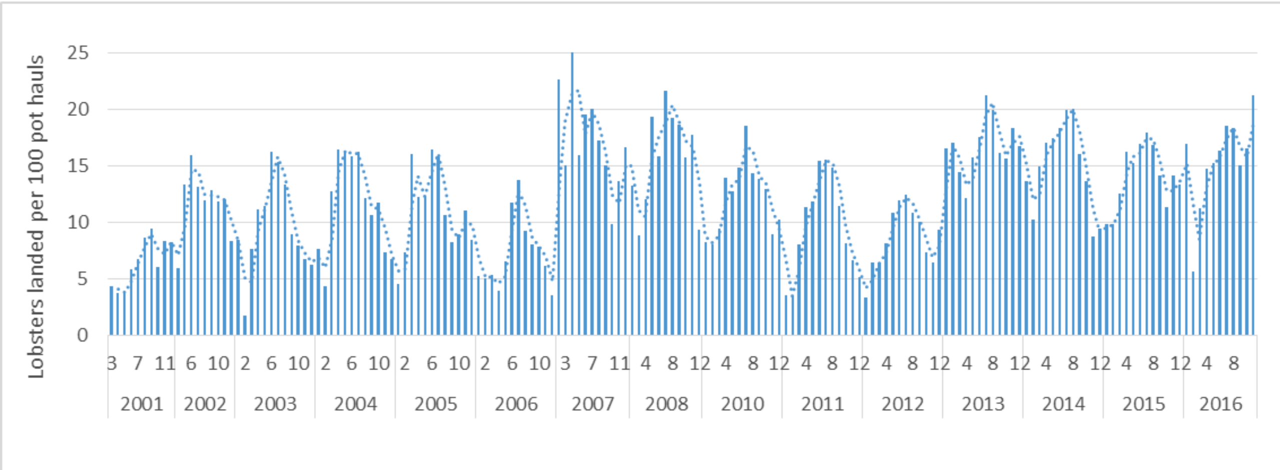


Figure 49. Nominal monthly average landings of legal lobsters per 100 pots hauled from 2001-2016.

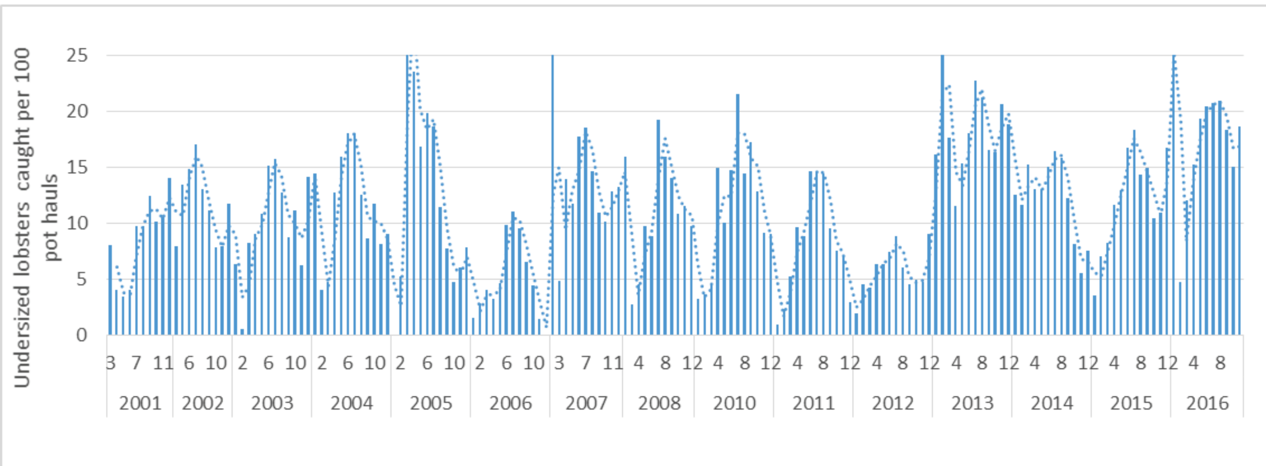


Figure 50. Nominal monthly average landings of undersized lobsters per 100 pots hauled from 2001-2016.

9 Glossary

Accuracy A measure of how close an estimate is to the true value. Accurate estimates are unbiased.

Benthic An animal living on, or in, the sea floor.

Bonamia (ostrea) A parasite of native oyster which infects the blood cells and causes mortality of oysters.

Biomass Measure of the quantity, eg metric tonne, of a stock at a given time.

Bi-valve A group of filter feeding molluscs with two shells eg scallops, cockles.

Cohort (of fish) Fish which were born in the same year.

Cohort analysis Tracking a cohort of fish over time. Length cohort analysis tracks length classes over time using growth data

Demersal (fisheries) Fish that live close to the seabed and are typically targeted with various bottom trawls or nets.

Ecosystems are composed of living animals, plants and non living structures that exist together and 'interact' with each other. Ecosystems can be very small (the area around a boulder), they can be medium sized (the area around a coral reef) or they can be very large (the Irish Sea or even the eastern Atlantic).

Exploitation rate The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis). For example, if 720,000 fish were caught during the year from a population of 1 million fish alive at the beginning of the year, the annual exploitation rate would be 0.72.

Fishing Effort The total fishing gear in use for a specified period of time.

Fishing Mortality Deaths in a fish stock caused by fishing usually reported as an annual rate (F).

Fishery Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea).

Fishing Licences A temporary entitlement issued to the owner of a registered fishing vessel to take part in commercial fishing.

Fleet Capacity A measure of the physical size and engine power of the fishing fleet expressed as gross tonnage (GTs) and kilowatts (KWs).

Fleet Segment The fishing fleet register, for the purpose of licencing, is organised in to a number of groups (segments).

Management Plan is an agreed plan to manage a stock. With defined objectives, implementation measures or harvest control rules, review processes and usually stakeholder agreement and involvement.

Management Units A geographic area encompassing a 'population' of fish de-lineated for the purpose of management. May be a proxy for or a realistic reflection of the distribution of the stock.

Minimum Landing Size (MLS) The minimum body size at which a fish may legally be landed.

Natura A geographic area with particular ecological features or species designated under the Habitats or Birds Directives. Such features or species must not be significantly impacted by fisheries.

Natural Mortality Deaths in a fish stock caused by predation, illness, pollution, old age, etc., but not fishing.

Polyvalent A type of fishing licence. Entitlements associated with these licences are generally broad and non-specific. Vessels with such licences are in the polyvalent segment of the fishing fleet.

Precision A measure of how variable repeated measures of an underlying parameter are.

Quota A portion of a total allowable catch (TAC) allocated to an operating unit, such as a Vessel class or size, or a country.

Recruitment The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population that year. This term is also used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their second year would be age 2 recruits.

Recruitment overfishing The rate of fishing, above which, the recruitment to the exploitable stock becomes significantly reduced. This is characterised by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year.

Reference points Various reference points can be defined for fished stocks. These can be used as a management target or a management trigger (i.e. point where more stringent management action is required). Examples include fishing mortality rate reference points, biomass reference points, indicator eg catch rate reference points or those based on biological observations.

Sales Notes Information on the volume and price of fish recorded for all first point of sale transactions.

Shellfish Molluscan, crustacean or cephalopod species that are subject to fishing.

Size composition The distribution, in size, of a sample of fish usually presented as a histogram.

TAC Total Allowable Catch

Vivier A fishing vessel, usually fishing for crab, with a seawater tank(s) below decks, in which the catch is stored live.

VMS Vessel Monitoring System

"a thriving maritime economy in harmony with the ecosystem and supported by the delivery of excellence in our services"

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